An exploration into registered nurses' knowledge of adult fever and associated management decisions

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DECLARATION

I hereby declare that this thesis has been completed by myself and that the work has not been submitted towards any other degree or professional qualification. I confirm that the work I submitted is my own except where stated otherwise by reference or acknowledgement.

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ABSTRACT

Introduction: This study explored nurse's clinical decision making in the context of fever management. It aimed to understand how nurses use knowledge of fever in their decisions on pyrexia-related nursing interventions when managing adult patients' fever. The management of fever has always been an enigma to health care professionals. Fever may be a result of many causes, infective or non-infective. Nurses' fever management can be affected by knowledge, beliefs and patient's needs. This research explored how knowledge acquisition influenced nurses' decisions in the management of fever, and identified factors that affected this knowledge acquisition.

Materials and Methods: A mixed methods approach was used with a validated questionnaire designed to gather information about nurses' knowledge of fever and fever management. This was followed up by semi-structured interviews to explore the relationship between knowledge and management of fever. The survey was distributed through the Royal College of Nursing and NHS health boards to registered nurses in Scotland. The data was collected from January 2017 to September 2017.

Results: A total of 177 questionnaires were completed. The questionnaires were scored with a correct answer 1 point, while a wrong answer -1 point. If the participants answered "not sure", a score of 0 was given. The mean total score in the knowledge section was 0.47 in a potential range of ± 17. Only 49.2% of participants scored above 0 indicating more correct than incorrect answers. The majority of participants (94.4%) showed no clear understanding about what temperature is defined as fever and (75.1%) the degree of fever that could lead to physical damage to the individual. When managing fever, 146 participants would first choose to employ paracetamol. In the decision making process, 49.2% of participants used their independent nursing judgement to manage fever, while 15.8% followed the national guidelines as their primary rationale and 15.3% made their decisions based on medical direction. Factors relating fever knowledge to fever management were analysed. Use of the Sepsis Six bundle, confidence, intuition and fever phobia were significantly related to fever knowledge and fever management. The process of gaining fever knowledge was through analytic reasoning (explicit knowledge) and intuitive reasoning (tacit knowledge). The relationship between fever knowledge and management was not direct. Dual Process Theory was used to explore how such knowledge was employed in the decision-making processes of fever management. Dual Process Decision making explained fever management as an interplay of both intuitive decision-making and rational decision-making.

Conclusions: This study showed that in the majority of situations fever management was based on intuitive decision making often related to routine clinical algorithms or practices that were not always appropriate to the situation. Most clinicians would choose to treat a fever even when there was no clear evidence of clinical benefit to support such an approach, resulting in overtreatment. A greater understanding of the appropriate use of analytic and intuitive reasoning in clinical decision making could improve practice in this context.

LAY SUMMARY

Fever is a common symptom observed in the clinical environment. It can arise from an infection or from other causes. Nurses' fever management can be affected by their knowledge, beliefs and the patient's needs (Trail-Mahan et al., 2013). Understanding how nurses use knowledge of fever in their decisions on nursing interventions to lower temperature when managing adult patients' fever is important. Guidance suggests that medication to lower temperature in moderate fever should only be provided to relieve discomfort instead of being routinely administered. Currently there is no evidence showing that treating a fever will decrease the length of an illness. Some studies suggest that antipyretics and cooling techniques may actually prolong an illness. This study aimed to understand how nurses use knowledge of fever in their clinical decisions when managing adult patients' fever. A validated questionnaire designed to gather information about nurses' knowledge of fever and fever management was used, and followed up by a number of semi-structured interviews to explore the relationship between knowledge and management of fever. The survey was distributed through the Royal College of Nursing and NHS health boards to registered nurses in Scotland. The data was collected from January 2017 to August 2017. A total of 177 questionnaires were completed. The results showed that the majority of participants did not have a clear understanding about the temperature that is defined as fever or the degree of fever that could lead to physical damage in an individual. There was concern about the lack of overall knowledge of fever. Results for fever management showed that most participants would routinely give paracetamol based on their independent nursing judgement. Fever management based on intuitive knowledge was most common. Though both analytic and intuitive knowledge use was also seen as described by the dual process theory of clinical decision making. A greater understanding of the appropriate use of analytic and intuitive reasoning in clinical decision making could improve nursing practice in managing fever.

Content

CHAPTER ONE: INTRODUCTION

1.1 Introduction

The purpose of this study was to explore nurses' clinical decision making in the context of fever management. It aimed to understand how nurses use knowledge of fever in their clinical decisions on pyrexia-related nursing interventions to manage adult patients' fever.

To achieve the research aim, the objectives of this research were

- To understand nurses' decision-making process in the management of fever
- To explore how knowledge acquisition influences nurses' decisions in the management of fever
- To identify factors that influence the knowledge acquisition in the management of fever.

This chapter introduces and examines the various kinds of theoretical frameworks that are used to connect fever knowledge and management. First, the different types of nurses' fever knowledge are discussed. The knowledge into management framework that relates nursing knowledge to clinical care management is presented. Then, how nurses' knowledge is embedded in their clinical decision-making approaches is introduced. Finally, the various decision-making models are presented via their clinical decision-making approaches.

There are many definitions and interpretations of fever and its management, which this chapter will explore. They include the different grades of fever and different types of body temperature measurement, and are followed by a discussion of the advantages and disadvantages of fever. An overview of the historical context of fever is provided. Details of the different types of antipyretics are also explored. Although there are many causes of fever, infection is the one that concerns clinicians the most. With an emphasis on infectious disease, relevant care guidelines identified as the Sepsis Six are presented. Finally, a brief guide of this thesis is provided.

1.2 Frameworks for translating knowledge acquisition to management of fever

Fever management in the clinical area has, traditionally, been nurse-led based on judgement and experience. It is important to understand the basis on which nurses make such decisions in practice. Nurses’ clinical decision making is fundamentally based on their education, training and experience (Kiekkas et al., 2013; Kiekkas et al., 2014; Sonğur et al., 2018). It is crucial for them to use the best available evidence as a foundation for their clinical practice (Nursing & Midwifery Council, 2018). The following section introduces the theoretical frameworks that can explain decision making linking fever knowledge to management. Knowledge of fever guides how nurses manage fever in the clinic. Knowledge is embedded in clinical decision-making approaches and models.

1.2.1 Types of knowledge

Knowledge can be gained in many ways, through life experiences and education. Studies in epistemology show that knowledge can be divided into two broad types: explicit knowledge and tacit knowledge (Brown and Duguid, 1998). These two types of knowledge are formed and used differently (Smith, 2001; Pritchard, 2006; Collins, 2010). Explicit knowledge is the knowledge that can be accessed and verbalised. It includes information that can be described in formal language such as the content of a lecture or scholarly publication. Explicit knowledge is usually gained through formal education and/or structured study. It is developed as reliable, high-quality knowledge that can be stored in a ‘hierarchical database’ in the mind of an educated individual (Smith, 2001; Pritchard, 2006; Collins, 2010). Tacit knowledge, as proposed by Polanyi (1958), is knowledge that we do not directly verbalise. It is the knowledge one 'just knows' which lies outside the domain of rules and procedures and is difficult to articulate. It is the product of automatic, unconscious learning processes that involve practice rather than thinking, for example speaking one's mother tongue or recognising facial features (Smith, 2001; Heiberg Engel, 2008). Subsequently, the term 'tacit knowledge' became widely applied in personal knowledge, which indicated knowledge that was internalised by individuals (Cowan et al., 2000). This distinction about the types of knowledge fuelled debate about the way they are used (Cowan et al., 2000; Malerba, 2002; Zollo and Winter, 2002).

Tacit knowledge in nursing was applied to nurses' intuition about patients' conditions (Josefson, 1988; Leonard and Sensiper, 1998; Herbig et al., 2001; Gourlay, 2004). Although discussions of the role and function of tacit knowledge are fraught with ambiguity, it was found that tacit knowledge was strongly related to experience (Gourlay, 2004; Muthuveloo et al., 2017). On the one hand, tacit knowledge was suggested to facilitate adaptation during new situations, which enable individuals to act quickly without further deliberation. On the other hand, tacit knowledge could be said to hinder change since such knowledge is relatively fixed as it could represent the automaticity of daily routines (Argyris, 1999; Torff, 1999; Gourlay, 2004). As a result, Herbig et al. (2001) identified that tacit knowledge was sometimes based on naïve, even incorrect theories which, by definition, were not explicit and so difficult to amend. In contrast to tacit knowledge, explicit knowledge consisted of evidence, rules and policies that could be easily shared. Structured learning processes could be designed to remedy important knowledge deficiencies. Many organizations have created explicit knowledge management approaches to support and improve existing knowledge assets (Smith, 2001; Choi and Lee, 2002; Wong et al., 2013a; Roy and Mitra, 2018).

Although this distinction between tacit and explicit knowledge has been commonly used, arguments were put forward that asserted that knowledge should be viewed holistically as a single concept (Bergson, 1984; Heisenberg, 1958; Spender, 1996; Spender, 1998; Styhre, 2004; Wong et al., 2013a). According to Heisenberg (1958), tacit knowledge is a term embracing many important different notions but no widely shared detailed definition. Most published evidence suggests that tacit knowledge is difficult to share in knowledge transfer (Leonard and Sensiper, 1998; Argyris, 1999; Torff, 1999; Cowan et al., 2000; Eraut, 2000; Dhanaraj et al., 2004; Collins, 2010). While tacit knowledge can represent knowledge in practice, explicit knowledge represents knowledge based on measurable evidence embodied in stated rules. It seems that the flow between practice and stated rules is not fully expressed (Styhre, 2004; Wong et al., 2013a). As a result, the binary distinction of tacit knowledge and explicit knowledge representing the overall knowledge acquisition by individuals remains debateable (Spender, 1996; Styhre, 2004; Bogers et al., 2010).

In the field of nursing, Carper’s (1978) seminal work examined the notion of nursing knowledge and identified four categories of knowing. These four categories were: empirical, personal, ethical, and aesthetic knowing. Empirical knowledge, which is based on scientifically validated evidence that can be applied in nursing practice; aesthetic knowledge, regarded as the art of knowing, which focuses on the process of knowledge application; personal knowledge, which encompasses self-knowledge, knowing others and the relationships between individuals; and lastly, ethical knowledge involving the clinician’s moral and ethical stance in nursing practice. White (1995) proposed a fifth type of knowing, socio-political knowledge based on the interaction between nurses and their social, political and cultural environment. However, critics are concerned that the above classification of nursing knowledge is overly conceptual and difficult to observe or follow in real-life nursing practice (Higgins and Shirley, 2000; Jenkins and Thomas, 2005; Jacobs, 2013). Fawcett et al. (2001) suggested that the pattern of knowing developed by Carper lacks an evidence-base, and Estabrooks et al. (2006) also questioned its application to clinical practice. It would seem that the pattern of knowing also lacks synchronization between different types knowledge. As a result, it was argued that Carper's ways of knowing could not fully represent the process of nursing (Fawcett et al., 2001; Estabrooks et al., 2006).

Benner and Tanner (1987), addressing skills acquisition theory, contend that one of the elements of developing knowledge and expertise in nursing practice is based on the nurses' acquired 'know-how'. Know-how involves one's practical knowledge and ability to do something (Dubickis and Gaile-Sarkane, 2017). How to apply knowledge effectively in nursing practice is without doubt a primary issue.

Estabrooks et al. (2005) suggest that the knowledge that nurses most commonly apply in the clinical setting is drawn from their own experience and informal social interactions. Nurses do not often use knowledge acquired from established research sources and the latest scientific literature. Since decisions in clinical practice need to be evidence based, the use of informal or interactive knowledge, especially personal knowledge, is considered to be dubious (Jenks, 1993; Sweeney, 1994). The question of how knowledge is applied in the decision-making process is a complex one. How knowledge is translated through the decision-making process and then developed into nurses' management will be discussed in the next section.

1.2.2 Frameworks translating knowledge acquisition to clinical management

Many research findings have suggested that fever knowledge is correlated with experience and attitude (Chiu, 2012; Greensmith, 2013; Kiekkas et al., 2014; Baran and Turan, 2018). To date few theoretical frameworks have been developed to connect nursing knowledge and clinical care management (Ward et al., 2009). There are three types of 'knowledge transfer process frameworks' applied to management: linear, cyclical and dynamic multidirectional. Graham et al. (2006) presents a cyclical process of knowledge transfer in action. Figure 1.1 depicts this cyclical knowledge into action framework, with knowledge creation as the inner triangle, and the action cycle as the outer circle. In this model, when a problem is identified, knowledge-creation is activated to support the action cycle. The first step of generating knowledge is knowledge inquiry. After inquiry, knowledge synthesis occurs whereby useful knowledge is distilled. Finally, knowledge for solving the problem is produced. During the knowledge-creation process, the scope and amount of knowledge in use is reduced in each step.

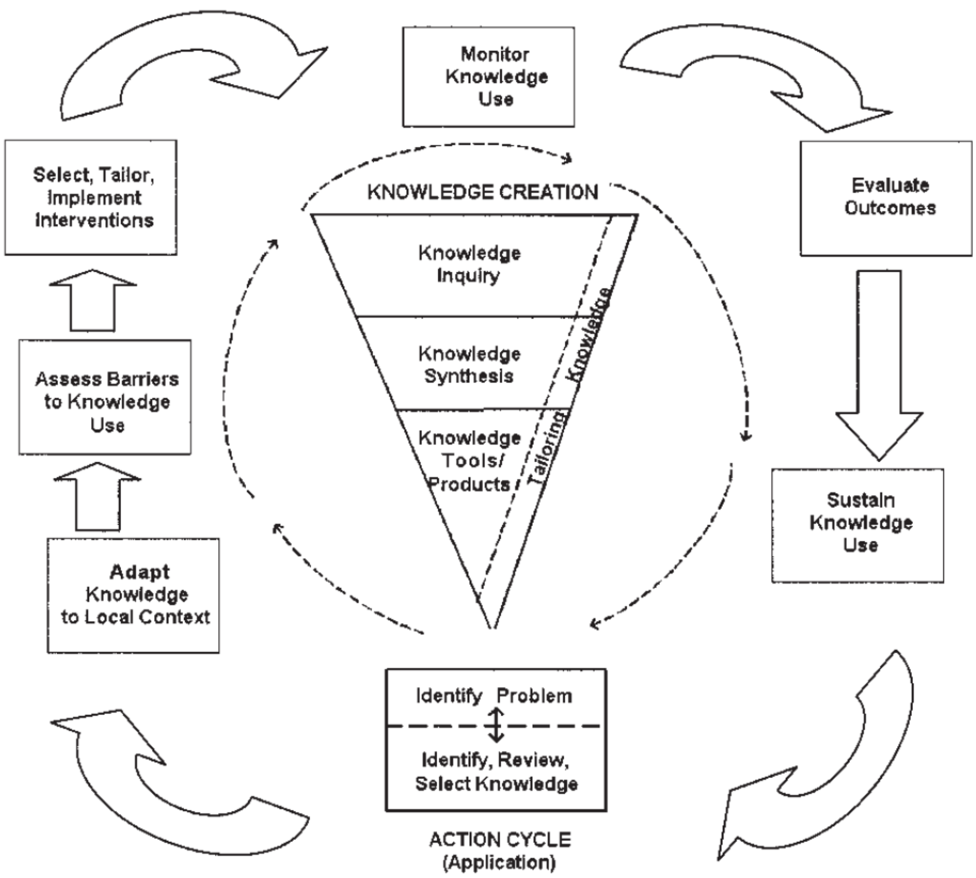

Figure 1.1 Knowledge into action framework (Graham et al., 2006)

The success of the knowledge production is confirmed in the action cycle. As shown in Figure 1.1, the knowledge is used, monitored and then evaluated in the action cycle. If the knowledge is sustainable, the action cycle continues and moreover that knowledge will be called up later when the same problem arises again. However, if the outcome of the performance evaluation is not satisfactory, a fresh knowledge creation process will be initiated. This framework is often applied in policy implementation, for example, the World Health Organisation (WHO) employs this framework when developing and promoting new policies. It should be noted that this knowledge into action framework applies to individuals as well as groups (Graham et al., 2006; Ward et al., 2009).

Davis et al. (2003) present a linear process of knowledge translation (Table 1.1). The start and end points of the process under this framework are identified with raising awareness, followed by agreement on and adoption of a clinical algorithm. The last step is to ensure there is adherence to the evidence in the nursing practice (Davis et al., 2003; Ward et al., 2009). This framework seeks to offer an efficient way to manage knowledge translation into action. At the same time, the framework is designed for groups and not individuals. Thus, the theory does not apply to the issue of clinical knowledge and care management with respect to individual nurses.

	Perspective of target (policy maker, consumer or clinician)			
Intervention	Awareness	Agreement	Adoption	Adherence
Predisposing	Distribution of printed information; journals; media campaigns; lectures, rounds; academic detailing			
Enabling		Opinion leaders; small group sessions for clinicians	Small group sessions for clinicians; patient education methods; clinical flowcharts or algorithms; academic detailing	
Reinforcing			Small group sessions for audit and feedback	Reminders (professional and patient), multiple interventions

Table 1.1 Pathman-PRECEED model for knowledge translation (Davis et al., 2003). The framework seeks to manage knowledge translation into action, which starts with raising awareness with clinicians, followed by agreement on and adoption of a clinical algorithm. The last step is to ensure there is adherence to the evidence in the nursing practice. This step by step process is to ensure the new intervention can be predisposed, enables and reinforced.

Most models for the transference of knowledge into action display the transfer as a dynamic, interactive, multidirectional process. However, most of these frameworks were developed in the fields of marketing and business and lack the complex knowledge component involved in nursing care (Ward et al., 2009).

Two conceptual frameworks are concerned with clinical practice management (Shin et al., 2001; Ward et al., 2009). Ward et al.'s 2009 conceptual framework is a model consisting of five components in the process of applying knowledge to decision making. The five components are knowledge/research, problem, utilisation, interventions and context barriers/support. Knowledge/research involves seeking the scientific evidence to support the relevant knowledge; problem points to the issue or problem encountered in clinical practice; utilisation represents how the knowledge is to be applied; intervention signifies the concrete course of action to solve the specific problem; and finally, support/context barrier indicates the challenges or supports that arise while the clinical care management is being conducted (Ward et al., 2009). Each element of this framework impacts and interacts with all others. Ward et al (2009) argue that this framework is idealistic, lacks detail and is untested in a clinical setting .

Shin et al. (2001) have proposed a framework involving a model that combines five research streams in a cyclic process: culture, knowledge location, awareness, evaluation, and absorption. The culture creating knowledge is the core segment and underpins the model. These four streams followed by knowledge evaluation constitute the conceptual knowledge to management framework (Figure 1.2). The detection of knowledge represents knowledge awareness. After detecting the knowledge, the knowledge would be evaluated to see if it could be usefully applied. Following evaluation, the knowledge would be checked for its suitablity for use in practical care management, which is called the knowledge location. The knowledge that could be applied and utilised would be evaluated again to see if it could be absorbed by individual nurses and leads to the knowledge absorption stream. If after the evaluation of the outcome of the nurses' knowledge absorption, if it was found that the knowledge could not be absorbed or was not well-established, then the process would start again seeking other knowledge and restarting the knowledge awareness stream.

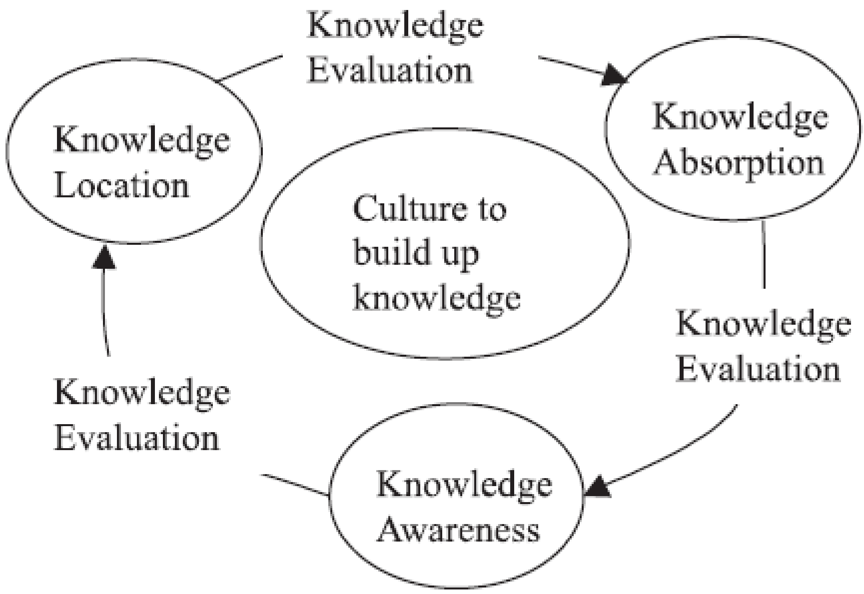

Figure 1.2 The five research streams framework, which illustrated the process of generating knowledge to management (Shin et al., 2001).

The above frameworks seek to explain how knowledge application occurs in clinical practice, adopting more or less of a reflective action approach.

1.3 Frameworks translating knowledge to clinical decision-making theories and activities

Nurses base their decisions for administering antipyretics on a number of factors including their colleagues' or patients' experience, clinical routine and their own experience and knowledge (Carey, 2010). However, it is unclear to what extent fever management is guided by explicit scientific fever knowledge. The conflicting advice given in academic publications and professional guidelines is not helpful as a guide to decision making (Graham et al., 1990; Purssell and While, 2013; Kanabar, 2014; NICE, 2017). Besides the above-mentioned knowledge into management frameworks, clinical decision-making (and judgement) theories also seek to explain the utilisation of knowledge specifically in the field of clinical assessment and management. Nevertheless, rather than focus on the process of applying knowledge into management, the clinical decision-making theories focus more on the process of how clinicians make decisions.

1.3.1 Clinical decision-making perspectives: normative, descriptive and prescriptive

In the clinical environment, for nurses in particular, decision making related to patient care is constantly required. Therefore, an understanding of the decision-making process, and knowledge of the elements of high-quality clinical decision making, are essential to minimise the risk of error and ensure patient safety. Many theories and models about decision making exist drawn from a variety of different disciplines: psychology and behavioural science, statistics, mathematics and economics, operations research, and management science (Cioffi, 2012). Notably, the seven-stage theory (Box 1.1) mentions several stages in the knowledge to management framework that are often overlooked, such as recognition and formulation of the problem, action and feedback (Bryans and McIntosh, 1996).

Recognition of the problem
Formulation of the problem
Alternative generation of hypotheses
Information search
Judgement or choice
Action
Feedback

Box 1.1 The seven-stage theory (Bryans and McIntosh 1996)

The decision-making process can be examined under three main approaches: normative, descriptive and prescriptive (Thompson and Dowding, 2002; Chapman and Sonnenberg, 2003; Cioffi, 2012; Thompson et al., 2013). The normative approach focuses on the outcome of a judgement and how to make a rational decision (Bond and Cooper, 2006;Edwards et al., 2007b). Rationality, logic and application of evidence-based decisions are key to normative models and particularly applicable to diagnosis (Thompson and Dowding, 2009; Standing, 2017). The algorithmic approach based on probabilities is used to make optimal decisions about management (Worachartcheewan et al., 2010; Chen and Fawcett, 2016).

Descriptive approaches aim to understand knowledge use when clinicians make decisions about care management, these models draw on psychological theories that explain how people make judgements (Thompson and Dowding, 2009). Descriptive work on decision making typically incorporates information processing theory (Newell and Simon, 1972) and concept attainment theory (Bruner, 2017). The descriptive approach considers such factors as complexity of the task, amount of time available, individual personality and values, and group relationships (Baron, 2004).

Concept attainment theory proposed by Aitken (2003) outlines a rational approach to decision making. Drawing on the work of Austin et al. (1956), Aitken (2003) presents the idea of concept attainment as a three-stage process. The development of attributes, patients' signs or symptoms of a disease, clinical data and medical history, is followed by concept formation or the establishment of a hypothesis that connects the attributes. This leads to the selection of an optimal strategy to be executed in the clinical setting (Thompson and Dowding, 2009; Chen and Fawcett, 2016; Standing, 2017). The theory points the way to accessing the most appropriate information and facilitates the identification of tenable and untenable hypotheses. This form of step-by-step information process is deemed a linear process. It is arguable whether a real-life decision-making process would follow such a linear course. Social judgement theory offers a further descriptive perspective on clinical decision. This theory explores how individual attitudes toward attributes, can eventually have impact on judgements (Thompson and Dowding, 2002).

Decision making in nursing, midwifery and medicine often involves hypothetico-deductive reasoning. Therefore, it is one of the most influential decision-making approaches in health-care settings (Thompson and Dowding, 2002; Thompson and Dowding, 2009). The process starts with data collection, followed by hypothesis generation, the attributes supporting the hypothesis are then interpreted, and, finally, the hypothesis is tested and evaluated (Elstein et al. 1978). Unlike the above descriptive models, the hypothetico-deductive method is focused on the evaluation of the hypothesis in a cyclical process similar to clinical reasoning (Levett-Jones, 2017). Clinical reasoning aims to ensure that clinical decision making is based on logical thinking to ensure that it is sound (Alfaro-LeFevre, 2015; Forneris et al., 2015; Hunter and Arthur, 2016; Kuiper et al., 2016).

Besides the normative and descriptive perspectives, much of the research on how clinicians make decisions has combined descriptive perspectives together with normative principles (Standing, 2017). Some scholars examine the heuristics and biases involved in judgements and decision making under uncertain conditions (Tversky and Kahneman, 1974). A special decision-making strategy is required, such as when facing complex situations with uncertainties and discontinuities; even descriptive approaches to decision making in general recognise the active role of the individuals concerned in interpreting the features and needs of a situation.

Existing research on both normative and descriptive perspectives is mostly focused on intuition, pattern recognition and heuristic reasoning as key parts of the process of arriving at a judgement (Hammond et al., 1986; Croskerry, 2009). Heuristics includes such elements as 'rules of thumb', intuitions, abbreviations, simple judgements and short cuts to be taken in a critical situation (Croskerry, 2005). However, if heuristics is unpicked, there is also a rational element in the decision-making process. A further discussion about rationale processes of decision making is presented in the next section (Section 1.3.2).

A prescriptive decision-making approach has also been developed in order to improve the decision-making process by critically examining how individuals make decisions (Thompson et al., 2013; Standing, 2017). Prescriptive models can guide educational interventions that present practitioners with alternative heuristics, to counteract untutored heuristics that lead to biases (Baron, 2012). Classical prescriptive decision-making theory makes use of decision trees. Decision trees (streamlined functional strategies for viewing complex situations) illustrate the main possible decision paths, then demonstrate the usefulness and outcome of each option (Worachartcheewan et al., 2010; Chen and Fawcett, 2016).

Social judgement theory draws on prescriptive and descriptive perspectives (Hammond et al., 1986). This theory focuses on how decision makers combine and weigh up cues to generate a judgement. Thus the theory investigates how decisions are actually made and the role played by the individual's knowledge in the decision-making process. Social judgement theory studies have shown that selection of cues is the most important factor impacting the overall decision-making process (Newell and Simon, 1972; Hammond et al., 1986).

1.3.2 Rationalism versus intuition

Decision-making can be mainly categorised into two types of approach: a rational systematic-positivist approach, where decision making is analytical and logical, and a phenomenological (interpretive) approach, registering a more intuitive process (Smith and DeCoster, 2000; Kahneman and Frederick, 2002; Kahneman and Egan, 2011). Tversky and Kahneman illustrated the cognitive basis for common human errors through heuristics and biases (Tversky and Kahneman, 1974; Tversky and Kahneman, 1978). The theory was later known as dual-process theory, which is one of the most frequently applied theories in decision-making (Croskerry, 2005; Croskerry, 2009). Just as reasoning theorists came to understand that unconscious biases could be overridden by an explicit effort at reasoning, so judgment researchers have reached a similar conclusion which can be illustrated in dual process theory (Tversky and Kahneman, 1974; Tversky and Kahneman, 1974; Kahneman and Frederick, 2002; Paley et al., 2007; Croskerry, 2009; Evans, 2010; Glöckner and Witteman, 2010; Bjørk and Hamilton, 2011; Kahneman and Egan, 2011). Dual process theory combines intuition with rational theory. In dual process theory, system 1 (S1) is described as fast, holistic and unconscious reasoning, and system 2 (S2) as slow, analytic and conscious reasoning (Figure 1.3). Chinn and Kramer (2013) show that intuitive judgement is a consequence of S1, while more rational judgement is the product of S2. Despite the contrasting natures of S1 and S2, it was found that S2 plays a more decisive role in the dual process decision-making system. Acting as a default system derived from S1, S2 can override or inhibit S1 (Evans, 2003; Evans, 2009; Evans and Stanovich, 2013). In other words, S1 is supervised by S2, when S1 is not supported by S2, errors in decision making are likely to occur (Croskerry and Nimmo, 2011). Although S1 and S2 appear to work together, they do not necessarily work at the same time (Evans, 2003; Croskerry, 2009; Chinn and Kramer, 2013). In the nursing literature, S1 is referred to as N1, while S2 is referred to as N2. However, there is a crucial difference between the N1/N2 distinction and the S1/S2 distinction (Paley et al., 2007; Croskerry, 2009; Kydonaki, 2011). According to Stein et al., (1998), N1 and N2 are granted equal weight and importance in identifying patterns of knowing. The roles of N1 and N2 are deemed complementary and a combination of the two allows nurses to grasp the whole clinical situation in a decision-making scenario (Paley et al., 2007; Croskerry, 2009; Kydonaki, 2011). Notably, while decision making in N1 implies that judgements involve rapid response, N2 decision making employs protocols and makes use of clinicians' explicit knowledge. As a result, the outcome of judgements from both systems suggests that the dual process decision making might not necessarily reflect just an individual's knowledge, but the process of how the decision is made (Paley et al., 2007).

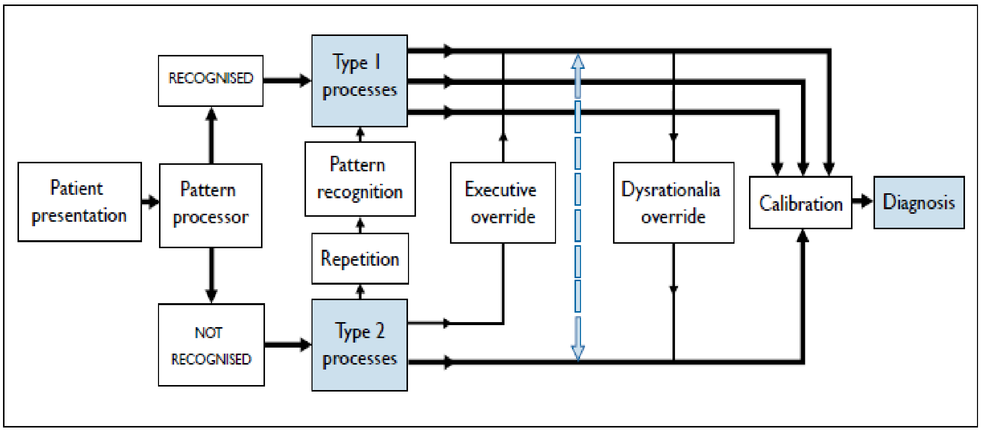

Figure 1.3 Dual process theory (Croskerry and Nimmo, 2011).

The heuristics and biases in decision making are used to explain both S1/S2 and N1/N2. Particularly in clinical practice, the use of heuristics and biases is examined by comparing expert and novice nurses' decision making (Paley et al., 2007). Heuristics in decision-making theory represents an immediate decision that may be the speediest strategy in a stress situation but not the best overall method for decision making (Thompson et al., 2013). The first heuristic system was proposed in the 1980s by Kulilowski, who interpreted the disease process using a descriptive model and then developed consultation systems for neuro-ophthalmology, eye infections, rheumatology and pathology (Wagholikar et al., 2012; Chen and Fawcett, 2016). Heuristic algorithms facilitate automated access to knowledge on the basis of particular cues. However, it has been shown that over dependence on such fast approaches can lead to systematic 'biases' in reasoning, dubbed as heuristics, particularly in uncertain situations. Benner and Tanner (1987) state that most day-to-day nursing practice is conducted on the basis of the nurses' working competence as 'know-how'. In an uncertain situation, an expert will be aware of the complexity and will hesitate while making a decision to avoid choosing a heuristic that leads to biases. Many situations could elicit such a heuristic outcome, for example, assuming the patient's fever symptoms are due to infection. Kahneman and Frederick (2002) coined the term 'attribute substitution'. Attribute substitution occurs when an assumption is made and tied to an attribute that could eventually lead to forming a wrong judgement. For instance, a mechanically ventilated patient with increased body temperature is at risk of sepsis. This assumption is based on the fact that high temperature is associated with sepsis. However, the assumption might be wrong (Kydonaki, 2011). It is, therefore, essential that the rational system (S2/N2) serves as a default to assess such conditional assumptions (Tversky and Kahneman, 1974; Kahneman and Frederick, 2002). Another possible situation that could arise in heuristics is the structural availability bias, when an assumption is made on the basis of the most readily available attribute in memory. In such cases, individuals try to recollect similar experiences; however, for a novice clinician, the paucity of similar experiences could lead to significant errors in judgement (Benner and Tanner, 1987; Paley et al., 2007; Kydonaki, 2011). A further heuristic, the representativeness heuristic, is observed when individuals draw on the perceived frequency of events in making a decision. Memory based recall is also employed in the representativeness heuristic, but relying solely on the accuracy of one’s memory is not recommended and can lead to incorrect judgements (Kydonaki, 2011; Evans and Stanovich, 2013). It is hypothesised that the risk of cognitive errors made by an unchecked and unsupervised S1 can be minimised with supervision by S2, as explained by the dual process theory (Paley et al., 2007). Nevertheless, heuristics is not necessarily used in every situation, especially in unfamiliar circumstances. In those cases, rational elements would be involved in the decision-making process (S2). While employing S2, the human brain would involve a selection of attributes and a selection of underpinning knowledge or guidance to lead to a decision (Kahneman and Frederick, 2002; Croskerry and Nimmo, 2011; Kahneman and Egan, 2011).

Even though dual process theory is commonly applied in decision-making of many fields, it has its critics. Firstly, it was argued that if S1 and S2 were the only two types of process which interact during the decision making process, then based on the interaction, behaviour would be highly predictable (Evans and Stanovich, 2013). However, until recently, predicting human behaviour is still a challenge (Sugrue et al., 2005; Passos et al., 2008; Brembs, 2010; Kerckhove et al., 2016). In addition, the most persistent fallacy in the critique of dual-process theories is the idea that S1 processes are responsible for all the inappropriate decisions and that S2 processes necessarily lead to correct responses (Evans and Stanovich, 2013). Many arguments about S1 in processing cognitive biases suggest that S1 is not ruled-based, while S2 is a rule-based cognitive process (Evans, 2010; Kruglanski and Gigerenzer, 2011; Evans and Stanovich, 2013). Nevertheless, studies also suggested that both S1 and S2 can be rule-based (Kruglanski and Gigerenzer, 2011; Evans and Stanovich, 2013). Biases may exist in S2 as well as S1 (Klauer et al., 2010; Singmann et al., 2016). Finally, it has been suggested that more elements should be included in decision making, such as individuality, memory capacity and intelligence, as well as intuition and reasoning (Evans and Stanovich, 2013). Such elements could influence S2 and lead to biases while processing S2 (Stein, 1996; Stein et al., 1996). It would seem that most debates about dual process theory were towards whether S1 and S2 could fully explain decision-making.

1.3.3 From novice to expert

Dreyfus and Dreyfus (1986) view the decision-making process in terms of the practice of applying knowledge in the clinical setting. Their model categorises individuals into five levels according to skill acquisition, experience and expertise. The first level is novice beginner, followed by advanced beginner, competent, proficient and, finally expert. According to Dreyfus and Dreyfus (1986), good decisions are made intuitively by professionals with expertise. All of the five stages are grounded in knowledge that has been acquired from ample clinical experience.

The Dreyfus (1986) model shows that purely intuitive behaviour should only be followed by experts. At the same time, while expert nurses may not always follow intuitive behaviour, experienced nurses often have obtained their intuition in decision making situations. It is "possible to have experience without expertise but virtually impossible to have expertise without experience" (Cert and Wilcockson, 1996: 672).

Many have criticised Dreyfus's approach as over-emphasising the intuitiveness and tacit features of learning (English, 1993; McPherson, 2005; Peña, 2010). It was questioned whether Dreyfus's model could explain problem-solving in complex clinical situations where it is essential to take the rich interplay between the implicit and explicit forms of knowledge into consideration (Eraut, 1994). Concerns about the definition of experts within Dreyfus's model have been expressed (Lampert and Clark, 1990; Cioffi, 1997; Selinger and Crease, 2002; Carraccio et al., 2008; Steinkamp et al., 2008). Defining an expert was difficult as the characteristics of an expert can depend on clinical culture (Cioffi, 1997; Selinger and Crease, 2002; Carraccio et al., 2008; Steinkamp et al., 2008). Despite its many critics, the novice-expert model has been useful in highlighting the significance of intuition and experience (Hung, 2001; Lyneham et al., 2008; Wilkesmann and Wilkesmann, 2011).

The model has been refined by Benner (2004) who further defines each level. Inexperienced or novice nurses are those who are new to a certain situation or task. As they can only do what they know, such inexperienced nurses also tend to have less confidence and knowledge. An advanced beginner has gained experience in recognising repetitive and meaningful cues in situations, while a competent nurse is valued by clinicians who have been working in a similar clinical setting for 2 to 3 years. These advanced beginner nurses use conscious, abstract and analytical thinking to make their decisions as well as setting short-term and long-term goals. A proficient nurse is one who is able to engage in a holistic decision-making process. When an unexpected situation arises, the proficient nurse will be competent to adjust or modify nursing-care plans and is able to access the right resources, such as the relevant guidelines, to make a response. Finally, an expert nurse does not usually have to depend on explicit guidelines, rules or principles to guide their decision making but rather is equipped to rely on their own intuitive grasp of situations (Benner and

Tanner, 2009). Generally, the expert nurse has the ability to recognise the key attributes of a situation and to form abstract knowledge, contextualise intellectual capacity and solve an uncertain situation efficiently (Benner, 2004).

In an effort to clarify this process, Benner and Tanner (1987) identified six steps in intuitive decision making. Pattern recognition is the first step, which is the process of identifying the key relationships among the cues in a situation. The second step is similarity recognition, i.e. the ability to recognise similarities and differences from current and past attributes. The third step is the ability to quickly identify and understand changes in a patient's presentation while providing routine care, this is called the 'understanding of common sense'. The fourth step is skilled know-how, while the fifth step is the ability to rank the attributes in the clinical presentations. The sixth and final step is the nurse's skill at choosing the right focus in a situation based upon their previous experience of similar situations. In summary, intuitive behaviours informed by clinical experience and knowledge can positively affect nurses' decision making and influence patients' quality of care and outcomes (Dreyfus and Dreyfus, 1986; Benner and Tanner, 1987; Benner, 2004). Expert nurses deploy an almost unconscious level of cognition while making a judgement. As a result, most of the clinical decision making among experts will not include explicit analytical skills (Dreyfus and Dreyfus, 1986; Benner and Tanner, 1987; Benner and Tanner, 2009).

1.3.4 The cognitive continuum model

Hamm (1988) presented the cognitive continuum theory, according to which the nature of any decision in a particular mode of thinking will fall into a range between experimental knowledge and intuitive behaviour. As illustrated in Figure 1.4, the theory also addresses the gaps along a continuum with intuition at one end and analysis at the other. How practitioners should approach making decisions is one of the areas of emphasis in the cognitive continuum theory (Thompson and Dowding, 2001; Cader et al., 2005; Standing, 2008; Thompson and Stapley, 2011).

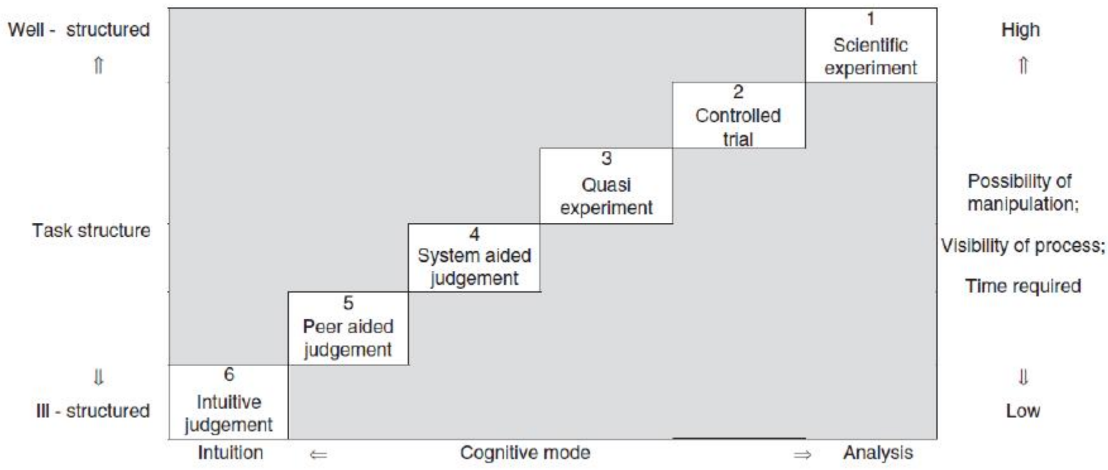

Figure 1.4 Cognitive continuum model (Hamm, 1988: 87)

The cognitive continuum model maintains that rational and intuitive modes of cognition are not mutually exclusive. At the same time, either a more rational or non-rational decision-making process could be adopted depending on the characteristics of a particular situation (Thompson et al., 2013). The model reflects analytical thinking, which aligns with descriptive information processing. Analytical thinking, which is a more rational decision making process, represents the first mode, while intuitive decision-making signifies the sixth and final mode. Besides intuition and rationalism, task structure, cognitive mode and available time are also considered in the model. The continuum theory shows that more structured tasks incorporate fewer pieces of information and are relatively amenable to an analytic approach (Thompson and Dowding, 2001; Cader et al., 2005; Standing, 2008; Thompson and Stapley, 2011). In less-structured tasks, intuition and incorporation of information are engaged (as presented in Figure 1.4). The continuum model shows that for poorly structured tasks with a large number of attributes and limited time, intuition is the most appropriate mode of cognition (Hamm, 1988; Thompson and Dowding, 2009; Standing, 2017). If, however, the task is well-constructed, with few information cues and considerable time available, the decision mode will be more analytical (mode 1). Evidence indicates that in healthcare settings, most decisions are based on 'system aided judgement' (mode 4), which involves a more analytical approach, such as clinical guidelines and/or decision trees (Hamm, 1988; Cader et al., 2005; Kydonaki, 2011). Analytic approaches based on guidelines and protocols can reduce the risk of error, especially when numerous decisions have to be made (Hamm, 1988; Cader et al., 2005; Kydonaki, 2011). According to Hamm (1988), the continuum theory provides a suitable cognitive mode for every judgement situation. While choosing the wrong cognitive mode can lead to inaccuracy in decision making, it may be difficult for a practitioner to consciously alter their responsive modes of thinking. Hamm (1988) states that by increasing the time available and removing redundant cues, better judgements can be made. In reality, there is often a mismatch between task and appropriate cognitive process, mainly because the theory is very quantitative-oriented and lacks the social aspect of decision-making. While most of the modes reflect rational decision-making. Intuition was considered as irrational or guessing (Offredy et al., 2008; Dhami and Thomson, 2012). Thompson (1999) found that analytical thinking would be accepted, when it is from 'experts' in senior clinical positions, while practitioners may reject the analytical reasoning from a less experienced colleague.

Although the cognitive continuum theory reflects the complexity of clinical decision making, it does not acknowledge the impact of various professions, different cultures, clinical experience and external factors on judgement and decision making. The lack of consideration given to the contextual nature of decision making weakens its validity in volatile, uncertain clinical situations (Hamm, 1988; Kydonaki, 2011). Consequently, Standing (2008) produced a revised version of cognitive continuum theory in nursing (Figure 1.5). The six modes of inquiry were extended to nine modes of practice.

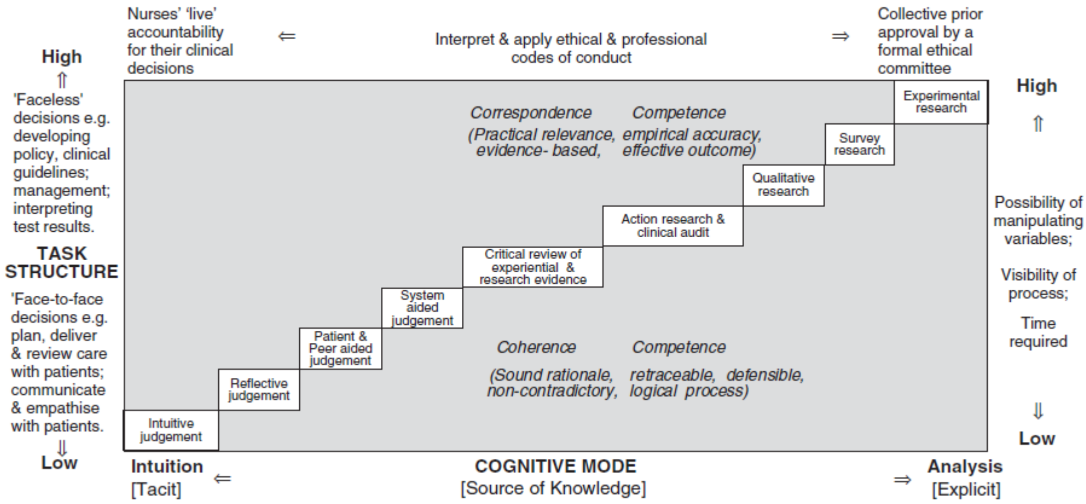

Figure 1.5 Standing's revised cognitive continuum of clinical judgement and decision-making in nursing – nine modes of practice (Standing, 2008).

In Standing's theory, the task structure is replaced with interpersonal and practical, face-to-face tasks, as opposed to research, policy, management, which were faceless. The nine practice modes are also supplemented by correspondence and coherence criteria, which enhanced the logic and consistency of the modes, to evaluate judgement/decision-making processes and outcomes, tacit-explicit sources of knowledge, and ethical/professional continua.

In Standing's theory, it is stated that nurses do not consciously reflect on experience (Thompson et al., 2004). Complementing personal experience with critical awareness of relevant research formed reflection in nursing, in which the 'reflective judgement' mode was considered to have a more intuitive element than 'peer-aided judgement'. Also the element of patient-centred care and clinical guidance was engaged, which shaped the 'patient/peer-aided judgement' and 'system-aided judgement'. Moreover, developing critical thinking skills is one of the most emphasised abilities in nursing. The enhancement of critical thinking is fundamental to the provision of evidence-based care (Flemming and Fenton, 2002; Mulhall and le May, 2004; Whittemore, 2005). Although Standing's revised cognitive continuum seems to have better support in clinical decision making, the mismatch between task and appropriate cognitive process was still observed as objective properties of tasks may be subjectively construed differently by the decision maker. Thus, limitation of applicability in the theory was noted.

This research aimed to understand how nurses use knowledge of fever in their clinical decision making. The above framework of clinical decision-making theories help to explain how nurses’ fever knowledge relates to their management. However, it is doubtful whether any such theoretical framework could fully represent how fever knowledge is employed in the clinical setting, or how fever management may be appropriately carried out. Such doubts indicate the need for further empirical research into the factors that influence professional nurses’ clinical behaviour in response to fever.

1.4 Fever

1.4.1 Definition and mechanism of fever

Any consideration of decision making and fever management necessitates an exploration of fever, its conceptualisation over time and principles of management. The human body has an impressive system designed to maintain the body temperature in the range of 36°C to 37.5°C. The hypothalamus contains a neural control centre that detects body temperature and can induce physical reactions, such as shivering and sweating, which are important in maintaining normal core temperature (Wunderlich, 1871; Mackowiak and Worden, 1994; Sund‐Levander et al., 2002; Broom, 2007; Tortora and Derrickson, 2018; Ritter et al., 2020). According to Weller (2014), a temperature above 37.5°C, also known as fever or pyrexia, indicates that the immune system is acting aggressively. The human body produces pyrogenic cytokines triggered by infectious disease, metabolic disease, auto-immune disease, toxic or for other unknown reasons, which act directly on the hypothalamus. Due to the complexity of fever mechanisms, the precise process of fever is not fully understood (Carey, 2010; Tortora and Derrickson, 2018; Ritter et al., 2020). However, it is known that cytokines, including interleukin and tumour necrosis factor, interact directly with toll-like receptors in cells of the anterior hypothalamus, which activate cyclo-oxygenase-2 and trigger the production of prostaglandin E2 (PGE2) on the brain side of the blood-brain barrier. PGE2 then interacts with receptors in the brain, stimulating the biochemical changes that result in fever. Those fever-causing cytokines or fever-producing molecules are defined as pyrogens (Romanvosky et al., 1996; Yamagata et al., 2001; Nakamura and Morrison, 2007; Nakamura and Morrison, 2010; Morrison and Nakamura, 2011; Horowitz, 2013; Marshall, 2014; Evans et al., 2015; Tansey and Johnson, 2015). Such reactions elevate the core body temperature, which induce febrile mechanisms. Those reactions help to increase and conserve body heat (Polderman and Herold, 2009; Scrase and Tranter, 2011; Tortora and Derrickson, 2013; Ling et al., 2015; Grant, 2018). As a result, an increased temperature is associated with the increased production of antibacterial substances, neutrophil migration and T cell proliferation. Such chemical actions also result in an increased heart rate, which facilitates the delivery of white blood cells to sites of infection or illness (Horowitz, 2013; Marshall, 2014; Tansey and Johnson, 2015).

Febrile temperatures rarely exceed 40.5°C, mainly because of the activation of antipyretics in the human body, which constrain the intensity of the febrile response and control the magnitude and duration of fever, especially when the body temperature exceeds 40.0°C (Hardy and DuBois, 1937; Nadal et al., 1971; Gonzalez, Nishi and Gagge, 1974; Roberts et al., 1977; Huizenga et al., 2001; Lepock, 2003; Nakamura and Morrison, 2007; Richardson and Lakhanpaul, 2007; Nakamura and Morrison, 2010; Morrison and Nakamura, 2011; Cheng et al., 2012; Tansey and Johnson, 2015; Herman, 2016; Tortora and Derrickson, 2018; Ritter et al., 2020). Therefore, temperatures above 40.5°C, defined as hyperpyrexia, may have detrimental consequences for immune function by suppressing apoptosis of immune cells and perpetuating pro-inflammatory cytokine responses (Carey, 2010; Narita et al., 2012; Wang et al., 2012; Kluger, 2015; Diaz et al., 2016; Oei et al., 2017).

Fever promotes immune system function in response to these agents. Inhibiting the fever may have an adverse effect on the patient resulting in a more serious illness. At the same time, patients with severe cardiorespiratory disorders or sepsis may be unable to compensate for the elevated metabolic demands of fever. There is evidence that fever reduction should not be routinely provided, and antipyretics should be subject to the same considerations as any other therapy (Gozzoli et al., 2004; Olson et al., 2008; Carey, 2010; Thompson and Kagan, 2011; Doyle and Schortgen, 2016).

1.4.1.1 Temperature measurement

A variety of sites are used to measure a patient's body temperature, tympanic membrane and oral are the most common. Researchers have investigated the accuracy and variation in measurement at the different sites. The measurement of rectal temperature is considered to be the most accurate method for determining core body temperature, but the procedure can detract from a patient's sense of dignity (Cattaneo et al., 2000; Lawson et al., 2007; Dai and Lu, 2012; Grainger, 2013; Grant, 2018). Tympanic thermometry, therefore, is currently the method of choice used at most healthcare facilities. Table 1.2 demonstrates the temperature, measured using different methods that are accepted as indicating a moderate fever. Little is discussed in the literature about how and when different technologies are used to measure temperature in clinical practice, although it is accepted that temperature is a fundamental vital sign when assessing a patient's health (Niven et al., 2012).

Measurement method	Temperature (°C) considered as moderate fever
Rectal temperature	38.0°C
Oral temperature	37.6°C
Axillary temperature	37.4°C
Tympanic membrane temperature	37.6°C

Table 1.2 Moderate fever definition (Sund-Levander et al., 2002; Dai and Lu, 2012; Grainger, 2013; NICE, 2017).

1.4.1.2 Cause of fever

When confronted with fever, most care providers immediately consider infection, which plays a role in 50% of fevers (Circiumaru et al., 1999; Bota et al., 2004; Toussaint et al., 2006; Laupland et al., 2008; Carey, 2010; Jevon, 2010; Chiu, 2012; Moon et al., 2018). Increased metabolism, such as metabolic disorder, injury and exposure to toxins play a role in 35% of fevers, while, in 15% of cases, either no diagnosis is made, or the pyrexia with no known cause resolves spontaneously (Konerding and Moffet, 1970; Bor et al., 1988; Gordon et al., 1992; Zeiner et al., 2001; Ferguson, 2007; Chiu, 2012; Ames et al., 2013; Moon et al., 2018). Infectious causes of fever can be categorised into five main types: bacterial, viral, fungal, parasitic and protozoal. Whereas non-infectious causes include transfusion reaction, deep body site hematomas, congenital heart failure, myocardial infarction, venous thromboembolic disease, acalculous cholecystitis and pancreatitis. Neurogenic fever, also a non-infectious type of fever, occurs frequently following subarachnoid haemorrhage (Thompson, et al., 2003; Niven et al., 2012; Seguin et al., 2012; Meier and Lee, 2017; Walter et al., 2016). Another common non-infectious aetiology is cancer. Many cancer patients develop fever, such as neutropenic fever (Toussaint et al., 2006; Ogawara et al., 2016).

Fever is a sign of an abnormality in the body. Regardless of whether the fever itself is treated, it is important to identify its aetiology which is often treatable (Richardson and Lakhanpaul, 2007; Carey, 2010; Jevon, 2010).

1.4.2 Historical context of fever

Historically, fever was most commonly caused by infectious diseases. Hence, the management of fever before World War II focused on infection control. After World War II, when antibiotics were more widely available and prescribed for patients with fever, there was a reduction in the incidence of infectious diseases. Some studies show that better living and social environments also contributed to the reduction of infectious diseases in the mid-20th century (Currie, 2005). Therefore, the debate as to whether it was antibiotics or social conditions that led to the decline in infectious disease had not yet reached a conclusion. However, the wider use of antibiotics was followed by the emergence of antimicrobial resistance (AMR) (Gray, 1999; Currie, 2005) since then the number of microbes resistant to antibiotics has been growing. Tackling AMR remains a priority for the WHO. Alongside infectious diseases, sepsis, which develops from severe infections, has also raised concern. Consequently, the Sepsis Six bundle was developed and implemented in the clinical setting. The sepsis bundle has been successfully employed with more than 80% of septic patients (Daniels et al., 2011; Burke et al., 2019); nevertheless, there is a chance that a patient with suspected sepsis is suffering from something other than sepsis.

1.4.3 Antipyretics and guidance Antipyretics and: guidance for management

Fever can be reduced by using antipyretic drugs to reset the temperature regulating centre of the hypothalamus, by using non-pharmacological antipyretics that encourage heat loss, or by using both methods (Flower and Vane, 1972; Styrt and Sugarman, 1990; O'Donnel et al., 1997; Aronoff and Nielson, 2000). NICE guidelines (2017) recommend avoiding techniques to reduce the temperature, especially when the patient is experiencing fever.

However, most doctors and nurses choose to treat pyrexia. Ryan and Levy (2003) stated that it is common for hospitalised patients with fever to receive pharmacological or physical antipyretic therapy although no established evidence suggests that treating a fever will decrease the length of the illness, and some studies have even shown that antipyretics and cooling techniques may actually prolong an illness (Haupt et at., 1991; Gozzoli et al., 2001; Gozzoli et al., 2004; Schulman et al., 2005; Thompson et al., 2007; Thompson and Kagan, 2010; Schortgen et al., 2012).

The NHS Sheffield Teaching Hospital has published a poster on guidelines for the treatment of pyrexia. These guidelines propose that antipyretics should be used to comfort patients physically and emotionally. Moreover, it suggests that pharmacological antipyretics are not recommended for routine use (Figure 1.6) (Foster et al., 2010). The debate on fever and the use of antipyretics continues, and although both detrimental and beneficial consequences of fever have been identified, it seems that most healthcare professionals routinely perform antipyretic treatment because it is an institutional habit (Saxena et al., 2011; Lee et al., 2012; Young et al., 2012).

Sheffield Teaching Hospitals NHS
NHS Foundation Trust

PYREXIA **Nursing Care Guideline no.162**

DEFINITION:- Elevation of body temperature above the normal range. Types of pyrexia can be categorised as: low grade (37-38°C), moderate to high pyrexia (38-40°C) and hyperpyrexia (above 40°C) Causes of pyrexia include: infection (systemic or local), disturbance of body tissue by trauma, malignancy, surgery or thrombosis, metabolic disturbance and CNS damage (e.g. CVA, brain tumour),hypothyroidism, myocardial infarction, pharmaceutical agents, heat stroke, blood transfusion reactions, alcohol withdrawal.
POTENTIAL ADVERSE EFFECTS (usually associated with hyperpyrexia):- hypovolaemia, metabolic acidosis, increased metabolic rate (causing an increase in oxygen demand), neurological impairment, potential rapid breakdown of muscle, death.

GOAL:-

- **Identify deterioration in patients condition and to ensure prompt interventions**
- **Early detection of problems associated with pyrexia**
- **Identify and treat the cause of the temperature**
- **Maintain patient comfort**

GUIDELINE TO NURSING ACTION:-

A. Record 4 hourly SHEWS observations. Inform the medical staff of abnormalities. Increase frequency of observations if indicated. The most sensitive time for detecting pyrexia is 6pm.
   i. Inform the medical staff of pyrexia even though this does not trigger a SHEWS score.
   ii. Be particularly vigilant with patients at increased risk of infection (e.g. neutropaenic, immunocompromised patients).
   iii. Neurology patients - please refer to local guidelines for care.

B. Monitor patient for any signs and symptoms of infection. Report any new or worsening symptoms to medical staff.

C. Attempt to identify the possible cause of the pyrexia and/or infection. Possible sites of infection include lungs, mouth, urinary tract, wounds, intravenous access sites/lines, catheters and drains.

D. Obtain samples suggested by symptoms/requested by doctors (e.g. MSU, stool, sputum, swabs, blood cultures).

E. Where potential causes of pyrexia are identified, liaise with the doctors re: the treatment plan. Implement the appropriate treatment plan, monitor and evaluate its effectiveness. Inform the doctor of any changing or worsening symptoms.

F. Provide measures to promote comfort and lower temperature if the patient is pyrexial.
   i. Reducing covers may be used for patient comfort if the patient is pyrexial, but they should not be removed during rigors as this will increase shivering and discomfort.
   ii. Provide cool, fresh and dry bed linen.
   iii. Provide reassurance during episodes of rigors.
   iv. Antipyretics, e.g. paracetamol, can be given as prescribed, however, routine use is not recommended and antipyretics should be used with caution as they can interfere with the bodies natural defence mechanisms and mask the symptoms of illness.

G. If the patient is able to take fluids orally encourage fluids. Monitor fluid balance if the patient is pyrexial for a period of time due to the risk of dehydration.

H. Promote regular mouth care as oral mucous membranes dry easily from dehydration.

I. Administer pharmacological agents as prescribed (e.g. antibiotics, intravenous fluids).

J. Monitor the patient's response to treatment and liaise with the medical staff about the patient's progress.

K. Maintain a safe environment, ensure the call bell is always within the patients reach and they know how to use it.

L. Ensure the patient and family (with patients consent) are fully informed about the plan of care and know to inform the nursing and medical staff if they develop any new or worsening symptoms.

PREFERRED OUTCOME:- For the patient to be managed appropriately in accordance with the nursing care guidelines.

Evidence Link:-
Dougherty, L, & Lister, S, (2008) The Royal Marsden Manual of Clinical Nursing procedures, 7th Edition, Oxford, Wiley -Blackwell .
Hilton, P, (2004) Fundamental Nursing Skills, 1st edition, London, Whurr Publishers.
Jevon P (2010) How to ensure patient observations lead to effective management of patients with pyrexia, Nursing Times, 106 (1), 16-18
Montague S, Watson R., Herbert R (2005) Physiology for Nursing Practice, Edinburgh, Elsevier
STHFT Evidence Based Council - Claire M Warnock/Julie Foster/Irene Mabbott/Cheryl Dixon/Niamh Leonard
March 2010 Review date 09 / 2012

Figure 1.6 NHS Sheffield Teaching Hospital guidelines for pyrexia (Foster et al., 2010).

1.4.4 The Sepsis Six bundle

Infectious diseases, cause millions of deaths globally each year (WHO, 2018), and continue to worry healthcare professionals, especially when the infection develops into sepsis (Singer et al., 2016; Rhodes et al., 2017). Sepsis is a syndrome of physiological, pathological and biochemical abnormalities induced by infection and defined as a life-threatening organ dysfunction caused by a dysregulated host response to infection (Bone et al., 1992; Slade et al., 2003; Rhodes et al., 2017). Evidence has shown that there has been a steady increase in the number of patients with severe sepsis from 2001-2010 (Harrison et al., 2006; McPherson et al., 2013). In the United Kingdom severe sepsis was estimated to be the cause of death in 37,000 patients annually and to use 50% of critical-care resources. Each hour's delay in administering antibiotics to patients with severe sepsis increases the risk of death by 7.6% (Daniels et al., 2011). Sepsis is a major public health concern. In 2006 the UK Sepsis Trust introduced an assessment tool called Sepsis Six to help healthcare professionals deliver more efficient and reliable care to patients who might be suffering from sepsis (Daniels et al., 2011; Singer et al., 2016). The use of Sepsis Six was linked to a 50% reduction in mortality and a decreased length of stay in hospital and critical-care units (Daniels et al., 2011; Hutcheson et al., 2012; McGregor, 2014). The Sepsis Six consists of a screening tool for sepsis management. If the patient shows any two of these six signs: 1) respiratory rate greater than 20 breaths per minute, 2) heart rate greater than 90 beats per minute, 3) temperature greater than 38.3°C or less than 36°C, 4) white cell counts greater than 12 x 10^9/l or less than 4 x 10^9/l, 5) acute altered mental status, 6) bedside glucose greater than 7.7 mmol/l (in non-diabetic patients), then sepsis is suspected (McGregor, 2014). Clinicians who suspect a patient is developing sepsis need to complete a set of six tasks: titrate oxygen to a saturation target of 94%; take blood cultures and consider administering antibiotic; measure serial serum lactates; provide intravenous fluid and commence the accurate measurement of urine output: the Sepsis Six bundle. This bundle was widely adopted by NHS Scotland and Wales (Medical

Directorate, 2013; Breen and Rees, 2018; Burke et al., 2019). The Scottish Patient Safety Programme employed the Sepsis Six as a model of best practice, and a sepsis care bundle was set up in early 2012 to support local teams in effectively delivering care to patients with sepsis (Franklin, 2013). Improvements in the recognition and management of sepsis have contributed to the recent reduction in mortality in Scottish hospitals. Because the launch of the Sepsis Six care bundle was a major success, NHS Scotland has created the Sepsis Screening Tool alongside the National Early Warning Scoring System app in 2014 to alert clinicians to deterioration in patients (NHS Education for Scotland, 2018).

When encountering a patient with fever, clinicians should use the Sepsis Screening Tool to evaluate whether the patient is at risk of sepsis. Besides fever, if the patient presents any of the other symptoms mentioned above, Sepsis Six should be instigated within an hour (McGregor, 2014). Early detection of sepsis can help to reduce the risk of life-threatening situations (Daniels et al., 2011). The Sepsis Six bundle is discussed frequently during health care professions' preparation programmes and the continuing professional development programmes that help to embed the care bundle in the clinical setting (Daniels et al., 2011; Burke et al., 2019). However, the side effects of overusing the Sepsis Six bundle have yet to be discussed. It is extremely unlikely that patients initially treated for sepsis will experience any acute side effects if they are later found to have a non-septic cause for their presentation. Nevertheless, there is a risk of hospital-acquired infections and increased AMR when implementing the Sepsis Six, especially when providing unnecessary antibiotics (Ogawara et al., 2016; Review on Antimicrobial Resistance, 2016). It remains unclear and it is of concern that no discussion about the prudent use of the Sepsis Six has been made. No discussion about whether fever could be induced by a non-septic cause.

Fever is a common clinical symptom encountered in 29% to 36% of hospitalised patients (McGowan et al., 1987; Bor et al., 1988; Dai and Lu, 2012; Seguin et al., 2012). As the provider of direct patient care, the bedside nurse is the primary decision maker regarding antipyretic interventions, regardless of whether an evidence-based protocol exists in a particular clinical setting (Thompson et al., 2007; Carey, 2010). Almost every nurse has had to care for a patient with fever. Therefore, fever management is a vital component of nursing practice because the outcome for the patient may be affected. Inconsistent fever management practices have been reported in the literature (Ferguson, 2007; Outzen, 2009; Nazarko, 2014; Doyle and Schortgen, 2016). The literature on fever management suggests that nurses strive to reduce patients’ fevers without assessing other symptoms (Thompson and Kagan, 2011). It is important that nurses understand the rationale for providing antipyretics so they can perform the appropriate care for fever patients. Accordingly, in a health-care culture of evidence-based practice, it would be necessary to identify the decision-making process of nurses’ fever management. A study by Kristensen et al. (2016) shows that when it comes to decision making, health professionals rely heavily on their past experience, knowledge of existing practice and knowledge of the local context. As a result, it is argued that research, clinical experience, patient experience and context-specific information, in reality, are blended and used simultaneously to influence practice.

1.5 Organisation of this thesis

This thesis is divided into seven chapters.

1) Chapter 1 is the general introduction and background to the study. In this chapter the motivation for the study is stated, followed by the aim and objectives of the research. The theoretical frameworks underpinning fever knowledge, decision-making and management are described alongside an introduction to fever and the historical context.

2) Chapter 2 provides a critical analysis of the literature on fever knowledge and management. There are two sections in the chapter. The first section concentrates on knowledge about fever, while the

second section explores the management of fever in the clinical environment.

3) Chapter 3 describes the design of this research. The rationale for the chosen mixed-method research methodology is explained. Details of the research process and data collection are given, and the analysis of both quantitative and qualitative data are discussed, along with the ethical considerations.

4) Chapters 4 presents the findings of this research, including the factors that are affected by fever knowledge and management. Details of each factor and the relationships between those factors are illustrated.

5) Chapter 5 explores the connection between fever knowledge and fever management. Two theoretical frameworks that explain the findings are identified and discussed, including the knowledge of dual-process decision-making theory. The development of a conceptual framework illuminating the interrelationships of the core concepts is presented. The chapter includes a discussion about the knowledge-building process of fever and related decision-making processes, and there is a critical review of the factors that play an important role in both fever management and knowledge. Recommendations are made for professional practice education and improvements to patient safety. The strengths and limitations of this study are discussed in terms of real-world research.

6) Chapter 6 summarises this research, and outlines the implications for practice with a concise conclusion

CHAPTER TWO: LITERATURE REVIEW OF FEVER KNOWLEDGE AND MANAGEMENT

2.1 Introduction

This chapter, begins by examining published empirical evidence on fever knowledge and fever management. It also presents an overview of what clinicians, especially nurses, know about fever and what factors might influence their knowledge of fever. The chapter then focuses on literature that investigates current practice in fever management. This explores whether antipyretics could have an impact on patients' hospital stay or mortality, and also what antipyretics are used in a clinical setting. Since many of the published articles are based on neuroscience, paediatric and intensive-care cases, fever management in those clinical settings is also discussed. Although different antipyretics are debated, there is little evidence available on the evaluation of fever management or how different fever management approaches are selected. Finally, the chapter critically evaluates the current evidence on fever knowledge and fever management in comparison with the fever management performed in the clinical practice. The discussion regarding existing evidence leads to defining the research aim and questions of this doctoral study.

2.2 Search strategy

To achieve the aim of the thesis, studies addressing both the knowledge of fever and the management of fever needed to be identified. Separate searches of the literature were conducted, first for publications on fever knowledge and then for publications on fever management. The search terms and inclusion criteria are outlined below. The majority of the published literature considered was limited to full-text articles in the English or Chinese literature. Studies were limited to the English or Chinese language because of a lack of translation resources, meaning that the researcher would be unable to analyse those in other languages. Studies were excluded if they were not peer-reviewed articles and not relevant to nurses' knowledge of fever. Articles published within a ten-year timeframe were selected. The initial review of the literature was conducted in 2014 with new sources added throughout the subsequent years. Research publications were retrieved from the *Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, Medline-OVID, Cochrane Library* and *DiscoverEd.*

The first search of the literature for articles relating to fever knowledge was conducted using the following key words: fever, temperature, pyrexia, knowledge, know* and nurs*. Because literature identifying nurses' knowledge of fever is scarce, the search terms did not limit the search to studies of fever in adults. Following the search, the reference lists in the identified studies were inspected to capture additional relevant references. Following this, a snowballing technique was used which encompassed searching identified articles, reference lists, author publications and citation searches, and repeating the process for each identified article in order to source other data that offered a more comprehensive view of the topic. In this stage 153 articles were identified, 97 abstracts were screened and, finally, 10 full-text articles were identified for inclusion (Figure 2.1).

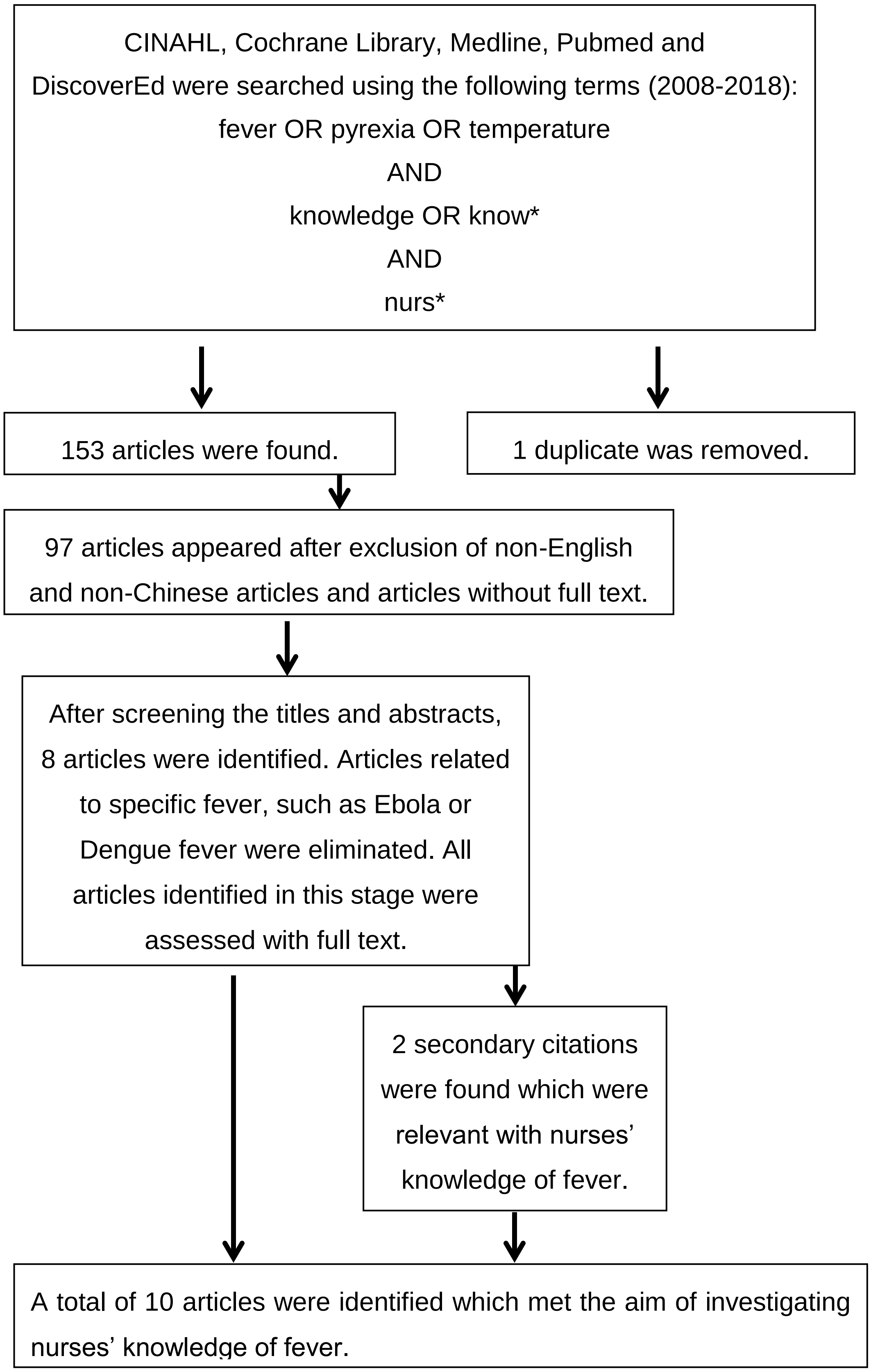

Figure 2.1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline (PRISMA) search strategy: Fever knowledge

The second literature search for articles relating to fever management used the following key words: fever, pyrexia, temperature, antipyretic, antipyresis, manage*, treat*, nur*, hospital* and adult. Compared with articles relating to fever knowledge, there are more articles discussing fever management. Therefore, ‘adult’ is included in the search term. Although adult is included as one of the key words, articles about paediatric fever were not excluded by the database searches. This search for articles relating to fever management found 420 articles, screened 229 abstracts, and identified 35 full-text articles for inclusion. Figure 2.2 shows the flow diagram of search strategies used in the second literature search.

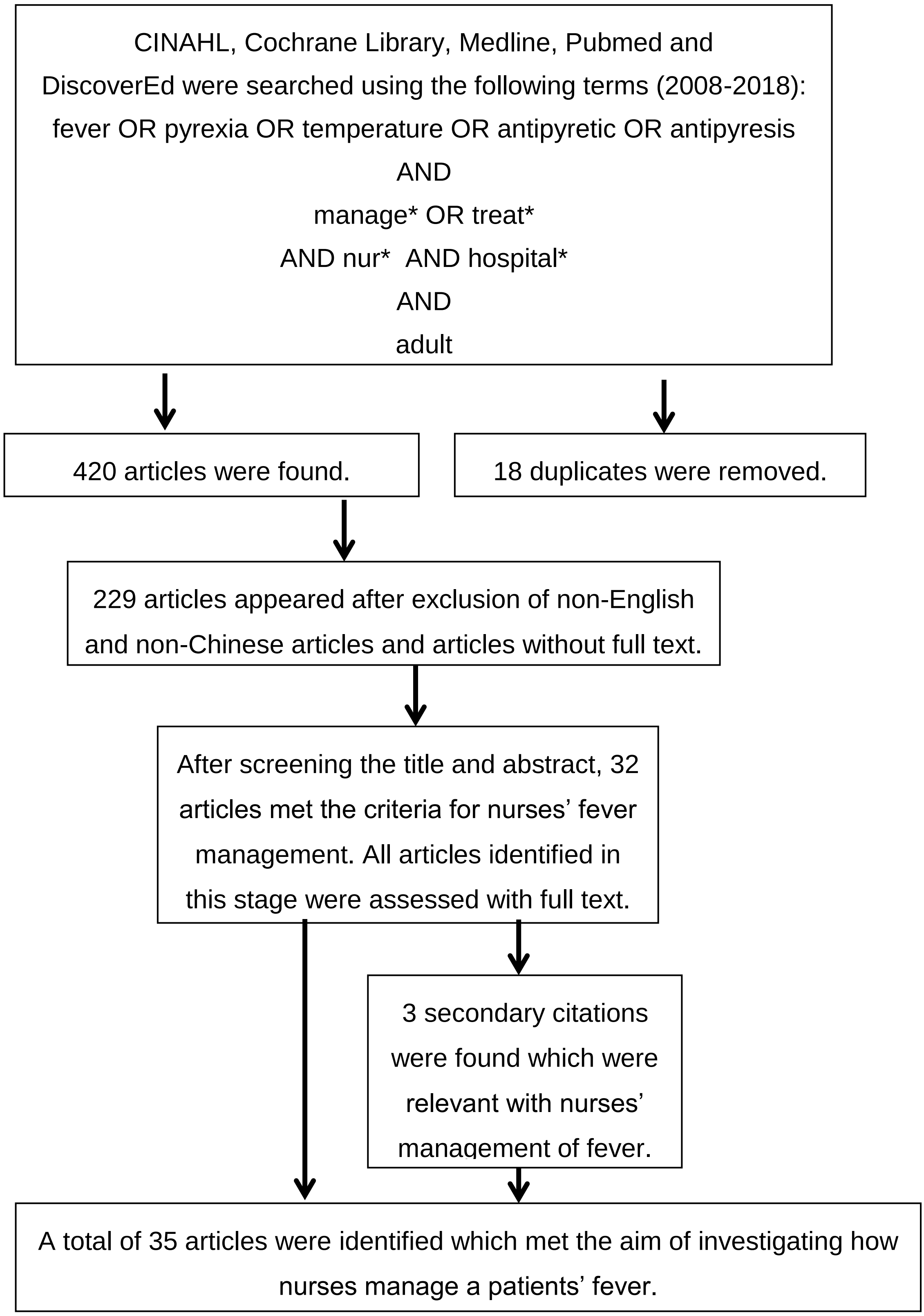

Figure 2.2 Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline (PRISMA) search strategy: Fever Management

2.3 Fever knowledge

Fever is one of the oldest clinical indicators of disease in the mammalian host and is one of the most common reasons why people attend emergency clinics worldwide (McGowan et al., 1987; Bor et al., 1988; Ogoina, 2011; Dai and Lu, 2012; Seguin et al., 2012; Baran and Turan, 2018). Fever is defined in the current glossary of terms for thermal physiology as “a state of elevated core temperature due to an elevation of the set-point” (IUPS Thermal Commission, 2001: 254). The human body has several mechanisms to maintain a normal temperature. The core human body temperature seldom rises above 40.5°C. When the body temperature is above 40.5°C, a patient is considered to have hyperthermia or hyperpyrexia at this temperature. Hyperthermia indicates that the body temperature regulation system is no longer functioning (Simon and Daniels, 1979; Holtzclaw, 1992; Simon, 1993; Lenhardt et al., 1996; Gelfand and Dinarello, 1998; Chatzipanteli et al., 2000; Thompson et al., 2003; Kurz, 2008; Gomez, 2014). Evidence shows that fever is a host defence mechanism. Although the elevated temperature may not always be beneficial, harmful effects are limited to specific patients. Most guidelines suggest that interventions for patients with fever should be to afford comfort and avoid complications (Aiyagari and Diringer, 2007; Scrase et al., 2011; NICE, 2017). Nevertheless, the established guidance is usually in paediatric neurological care. The absence of published guidelines on the use of pharmacological and non-pharmacological antipyretics in adult patients is noted. Moreover, there is a lack of robust evidence describing the signs and symptoms of fever that would support clinicians in recognising, monitoring and appropriately treating its course (Ames et al., 2017). The care of febrile patients has traditionally been a core competency for nurses which mainly includes measuring body temperature and administering antipyretics (Kiekkas et al., 2014). A study found that 86% of pharmacological antipyretics prescribed were written to be given ‘as needed’ at the discretion of the bedside nurse (Isaacs et al., 1990). Although this study is nearly 30 years old, the lack of data guiding fever management indicates that inconsistencies in fever management are likely to be the standard of care (Niven et al., 2012). Nurses’ fever management can be affected by their knowledge and beliefs, and also by patients’ beliefs and their requests for the administration of antipyretics (Walsh et al., 2006; Edwards et al., 2007a; Hutchinson and Johnston, 2008). Consequently, an understanding of fever and the febrile response is vital in the diagnosis, treatment and follow-up of various ailments and diseases (Ogoina, 2011). It is crucial that all nurses practice consistently in accordance with the latest scientific evidence. Therefore, understanding nurses’ knowledge about fever is very important. Greater knowledge of fever will guide more accurate assessments of the epidemiology of fever and its management.

The literature search identified only ten published articles on nurses’ knowledge about fever. Of these ten articles, five are on paediatric cases (Greensmith, 2013; Richardson and Purssell, 2015; Peetoom et al., 2016; Brick et al., 2017; Baran and Turan, 2018), and three are review articles (Ogoina, 2011; Scrase and Tranter, 2011; Purssell and Collin, 2016).

Only two pieces of research were found to meet the aim of understanding nurses’ knowledge of fever in adult patients (Chiu, 2012; Kiekkas et al., 2014). Kiekkas et al. (2014a) investigated the attitudes towards fever and antipyretics among nurses caring for hospitalised adult patients, to identify the predictors of these attitudes. The study was a descriptive cross-sectional survey in Greek hospitals. There were 458 questionnaires completed and returned. The research illustrated that intensive care unit (ICU) nurses had significantly better fever and fever management knowledge compared with nurses in medical and surgical wards. Overall the nurses’ knowledge about the physiology of fever, its management and the use of antipyretics was poor with only 62% of the nurses correctly responding to the questions. The nurses with the better fever knowledge scores were those who kept abreast of current evidence related to fever and antipyretics. Longer professional experience was associated with a more positive attitude towards lowering body temperature, and were less likely to allow a fever to run its course without using antipyretics. This result possibly suggests that clinicians traditionally believe that fever is harmful and practices of aggressively supressing fever play an important role in experiential knowledge of fever. The evidence implies that nurses with longer experience tend to rely more on experiential knowledge rather than seeking scientific evidence. Although the study showed evidence about nurses' knowledge of fever, the main purpose of the study was to investigate nurses' attitudes towards fever and the use of antipyretics for inpatients. Therefore, the design of the questionnaire and the way the questions were addressed is deeply connected to nurses' attitudes rather than nurses' knowledge.

A study of physicians' and nurses' knowledge, attitudes and practices in fever management was conducted by Chiu (2012). Similar to the results presented by Kiekkas et al. (2014a), the overall score on the knowledge question was about 67% from 251 participants. The question that most clinicians answered correctly related to temperature measurement, while the question with the lowest score, which was the question that most clinicians answered wrongly, related to the mechanisms of fever. The overall score was poor, with a score of less than 60% to more than one-third of the questions. Additionally, investigation of nurses' attitudes towards fever was performed in the study by using a four-point Likert scale. It was discovered that nurses were very confident about their knowledge of both fever and antipyretics. This study also indicated that nurses with more experience tend to be more confident in their fever management and more knowledgeable about fever. Although this study was relatively comprehensive in both fever knowledge and fever management, its design included the nurses' attitude towards fever, which had similar results to the knowledge questions so may suggest prejudice among participants while answering the questions.

The most recent studies about fever knowledge are in the area of paediatrics (Brick et al., 2017; Baran and Turan, 2018). A Turkish survey by Baran and Turan (2018) indicated an average score of 68% (n=126), similar to the previous studies by Kiekkas et al. (2014a) and Chiu (2012). The results showed that more than 75% of the nurses surveyed would immediately manage any temperature above 38.5°C. In addition, the majority of nurses would intervene in cases of fever with a warm application such as tepid sponging until the body temperature reduced by 1.5°C to 2°C. The study found no significant difference in fever knowledge scores between nurses’ educational status or their unit. However, inconsistencies in participants’ knowledge of fever and febrile convulsion were noted. The overall finding concluded that misinformation regarding fever and fever management may lead to inconsistent practice. The study also provided a training session relating to febrile convulsion and fever management. Accordingly, the session had a significant ($p=0.000$) impact on increasing knowledge levels. Although this research included a detailed assessment of nurses’ fever knowledge, the article only compared the knowledge level before and after the training session, without further explaining the assessment.

Another study surveyed attitudes towards fever among members in the UK Paediatric Intensive Care Society (Brick et al., 2017). The study found that 45% of respondents acknowledged a temperature threshold of 38.5°C or above needed to be managed, and those respondents would therefore not administer any antipyretics until the patient’s body temperature reached that threshold. It was reported that senior staff used a higher threshold than junior staff. This resonated with Benner’s framework about expert nurse, who has the ability to recognise the key attributes of a situation and to form abstract knowledge (Benner and Tanner, 1987; Benner, 2004; Benner and Tanner, 2009; Thomas and Kellgren, 2017). In the study conducted by Brick et al. (2017), it would seem that senior staff had more experience in fever patients. Therefore, senior staff were more precise with the when to administer the interventions. The study asked about opinions on adopting the NICE guidance, which advises that paracetamol should not be used with the sole aim of reducing body temperature. It was found that more than 30% of senior nurses thought their unit would be likely or very likely to accept the NICE guidance. However, fewer senior doctors thought the NICE guidance would be adopted in the clinical environment. It would seem that nurses were more positive when it came to implementing the policy. While this study involved more than 450 clinicians, only two questions associated with fever knowledge were asked. Most of the questions in the study investigated clinicians’ attitudes.

Greensmith (2013) invited one Irish children’s hospital to participate in a descriptive and cross-sectional survey. A total of 119 nurses were included in the survey which used a validated questionnaire. Of the twenty knowledge questions, 50.9% were correctly answered by the nurses. Of the eight questions relating to knowledge of the physiology of fever, 63.6% were correctly answered. Only 34.5% of the participants correctly answered that convulsions occurred in more than 25% of children. In the section on knowledge of antipyretic use in fever management, 58% of the questions were correctly answered. However, the results for knowledge of management during fever, indicated the management of fever related symptoms was poorer, with only 47.3% of questions answered correctly. Half of the questions were correctly answered by 59% of participants, while only 10.9% correctly answered that dehydration was the principal danger of fever. No more than 4.2% of participants answered at least 75% of questions correctly. Attitudes about fever were also evaluated. Most nurses (84.9%) thought febrile convulsions were the principal danger, while 81.4% of participants correctly did not believe that neurological damage is common in children with febrile convulsions. This indicated that most nurses thought febrile convulsions were harmful for patients, but did not often occur among fever patients. Regardless of the detailed description about paediatrics nurses’ fever knowledge, some limitations were recognised. This study was undertaken in one children’s hospital in Ireland; therefore, the sample may not be representative of the entire population of nurses caring for febrile children.

The five studies discussed above surveyed health care workers’ knowledge and attitudes about fever using a large number of participants (Chiu, 2012; Greensmith, 2013; Kiekkas et al., 2014; Brick et al., 2017; Baran and Turan, 2018). Although the questionnaires and study populations in the individual studies were different, the results are similar. The evidence suggests that nurses’ lack of knowledge about fever remains a concern (Chiu, 2012;

Greensmith, 2013; Kiekkas et al., 2014; Baran and Turan, 2018). In the studies conducted by Kiekkas et al. (2014a) and Chiu (2012), both knowledge and attitude were examined. It was questioned whether the similar questions on both knowledge and attitude would influence the responses to each other. For example, in the knowledge part, there was a question about the side effects and maximum dosage of antipyretics. However, in the attitude part, a question about the safety of antipyretics was also listed. It would seem that the knowledge question was implying a safety concern of antipyretics (Chiu, 2012). A similar design was observed in Kiekkas et al.'s study (2014). Moreover, questions with evidence were categorised in the attitude section, such as 'priority of care for fever should focus on identifying its cause rather than on its suppression' (Kiekkas et al., 2014) or 'the reason for providing antipyretics is merely to subside fever' (Chiu, 2012). For these two questions, which are supported by scientific evidence, there is doubt whether a Likert scale reflects the knowledge-related beliefs of respondents.

Despite a focus on the attitudes towards fever, the relationship between experience and nurses' knowledge was also analysed. While experience was found to have a significant impact on knowledge of fever management (Chiu, 2012; Kiekkas et al., 2014; Brick et al., 2017), education was discovered to have no significant impact (Kiekkas et al., 2014; Baran and Turan, 2018). Regarding demographic differences among wards or units, Kiekkas et al. (2014a) found significant differences between ICU nurses and nurses in medical and surgical wards. However, Baran and Turan (2018) found no significant correlation between nurses in different units in terms of antipyretic knowledge. Yet, in this study, the majority of nurses were from an ICU background. The limited diversity could be one of the main reasons that no significant correlation between nurses in different units and fever knowledge.

While most of the fever knowledge studies used questionnaires to examine knowledge and attitudes about fever, Peetoom et al. (2016) used a focus group to investigate caregivers' knowledge about fever in a paediatric clinic, focussing mainly on parents. The literature implies that different healthcare professionals have different judgements about fever symptoms especially when managing fever. The inconsistent information that is often provided consequently causes worry, confusion and uncertainty about fever management among parents. Peetoom et al. (2016) indicated that incoherent information offered by healthcare professionals, alongside a lack of general knowledge about fever, could reinforce fever phobia among parents. Many parents believed that fever could lead to brain damage, coma and death, as well as the more common fears of convulsion and dehydration. Purssell and Collin (2016) performed a systematic review and meta-analysis of the literature on fever phobia. The term 'fever phobia' was first raised by Schmitt (1980) to describe the anxiety and fear of fever among parents. The results of Purssell and Collin's review (2016) revealed that fear of fever remained, especially among parents, despite the benefits of diagnostics and treatment. This persistent fever phobia suggests that the fear could be cultural (Purssell and Collin, 2016). Nevertheless, a number of those worries, including the risk of brain damage, were, unfortunately, shared by some clinicians. Added to that, there is little evidence of reduction in fever phobia, which the clinicians might be able to think more about the rationale of fever rather than just supressing fever (Purssell and Collin, 2016). It is true that a very high body temperature can disrupt cellular metabolism and result in organ failure. Hyperthermia is the consequence of uncontrolled elevation in body temperature (Simon and Daniels, 1979; Holtzclaw, 1992; Simon, 1993; Lenhardt et al., 1996; Gelfand and Dinarello, 1998; Chatzipanteli et al., 2000; Thompson et al., 2003; Kurz, 2008; Gomez, 2014; Richardson and Purssell, 2015; Purssell and Collin, 2016). Pyrexia, also known as fever, in contrast, is a regulated increase in body temperature. As such, fear of fever is certainly the product of ignorance of the fact that any mortality or mobility from feverish illness could be caused by the underlying disease (Richardson and Purssell, 2015). The study conducted by Greensmith (2013) in an Irish hospital demonstrated that only half of the participants believed that fever had beneficial effects in children. Moreover, a total of 47% felt their nursing colleagues were fever phobic.

Fever is involved in many diseases. It is an ancient adaptive compensatory natural mechanism leading to immune activation (Kluger, 1991; Gregson and Mackowiak, 2004; Broom, 2007; Childs et al., 2010). In view of its integral role in the pathogenesis of disease, fever will remain a cardinal manifestation of old, new and emerging diseases, both infectious and non-infectious. It is thus imperative for healthcare professionals to continue to harness and expand the knowledge gained so far in the understanding of the febrile response, in order to improve on the diagnosis, prevention and management of numerous diseases characterised by fever (Ogoina, 2011).

The literature review revealed a limited number of papers on fever knowledge with only ten identified, which met the inclusion and exclusion criteria. All ten articles analysed nurses' knowledge and attitudes toward fever, these included three in the area of paediatric care and one in the area of critical care. It was clearly evident that nurses continue to be fever phobic, and the identified knowledge deficit was of concern. From a clinical and professional perspective, knowledge deficits, such as not knowing the peak absorption time or side effects of paracetamol, or the danger of fever, can contribute to inconsistent fever management practices (Scrase and Tranter, 2011). It was noted that the practitioners' level of experience of fever was associated with their level of fever knowledge. Although educational status was not significantly correlated with fever knowledge, educational programmes were identified as having a significant effect in changing attitudes and practice in the nursing management of pyrexia (Scrase and Tranter, 2011; Brick et al., 2017).

2.4 Fever management

Healthcare professionals rely on a raised temperature as being one of the vital signs to alert them to the febrile process and the need for intervention and appropriate management. A guideline for the management of feverish illness in children under 5 years old was established by NICE (2017). However, there is a paucity of evidence to guide the management of febrile adult patients without brain injury. Compared with hyperthermia, pyrexia is thermoregulation through the balance of heat production and heat lost to the environment (Carey, 2010; Jevon, 2010). Reducing blood flow to the peripheries reduces heat loss and shivering can increase heat production. Conversely, heat loss is increased by peripheral vasodilation and evaporative cooling elicited by sweating (Young and Saxena, 2014; Doyle and Schortgen, 2016). The advantages of fever include enhancing immune cell function; inhibiting the growth of pathogenic microorganisms such as the influenza virus, Streptococcus pneumoniae and meningitis; and increasing the activity of antimicrobial medications (Kiekkas et al., 2008; Kiekkas et al., 2013; Young and Saxena, 2014; Young et al., 2015). On the other hand, one of the penalties of fever is the increase in metabolic rate especially if it is accompanied by shivering. Evidence states that each 1°C increase in core temperature results in a 10% to 12% mean increase in energy expenditure alongside an increase of 20% in oxygen consumption (Shumacker et al., 1987; Manthous et al., 1995; Kluger et al., 1998; Hasday et al., 2000; Kiekkas et al., 2008; Jevon, 2010; Evans et al., 2015; Dai et al., 2015). The increases in oxygen consumption, heart and respiratory rates and cardiac output add a considerable burden to critically ill patients. The correlations between fever and patient outcomes have been reported by Dai et al. (2015). This study examined patients with hospital-acquired bacteraemia, and revealed that blunted febrile episodes may relate to greater risk of mortality in patients with bacterial infection. Healthcare workers should vigilantly assess patients who lack a robust pyretic response. A similar study exploring the relationship between body temperature and outcome among hospitalised patients with infection was conducted by Henriksen et al. (2016). The study showed that patients who failed to generate fever and were hypothermic, a body temperature below 36°C, had an increased risk of mortality. Likewise, Young et al. (2012) found that an elevated febrile temperature among critically ill patients with or without an infection was associated with decreased in-hospital mortality. For influenza infections, the degree of heat sensitivity appears to indicate the virulence of the strain. Strains with a peak temperature of ≤38°C tend to cause mild symptoms, whereas strains with a peak temperature of ≥39°C tend to instigate severe symptoms (Young and Saxena, 2014).

There is a myriad of methods used in the clinical environment to lower body temperature. Yet, the lack of strong evidence supporting the administration of both pharmacological antipyretics and physical cooling methods undermines the competency of clinicians' when managing fever (Carey, 2010; Jevon, 2010; Doyle and Schortgen, 2016). Antipyretic medications act by inhibiting the conversion of arachidonic acid to PGE2, stimulating the hypothalamus to reset the normal thermostatic set-point (Autret-Leca, et al., 2007; Chopra et al., 2009; Pierce and Voss, 2010; Mullins et al., 2011; Jefferies et al., 2012; Sherman and Sood, 2012; Sharif et al., 2016; Trippella et al., 2019). Pharmacological antipyretics that are frequently employed by clinicians include paracetamol, ibuprofen and other NSAIDs. Paracetamol is one of the most frequently applied antipyretics because of its effectiveness in reducing body temperature (Boyle et al., 2010; Young et al., 2015). It has been reported that the use of paracetamol also helps to increase skin blood flow and perfusion in critically ill patients. A significant decrease in blood pressure is observed with the change in blood flow (Boyle et al., 2010). Evidence suggests that skin vasodilator and vasoconstrictor systems, which account for the degree of perfusion, may be important haemodynamic responses involved in both the thermoregulation system and the regulation of blood pressure. Studies show that the administration of paracetamol may initiate the physiological mechanisms for heat loss, such as vasodilatation as well as the baroreflex control of blood pressure (Boyle et al., 2010). Although paracetamol has been proven to be effective at subsiding fever, it carries a considerable risk of adverse effects such as hypotension, gastrointestinal bleeding, and renal and hepatic toxicity (Roberts et al., 2015; Young et al., 2015). Another well-established medication, ibuprofen, is one of the NSAIDs that inhibits the formation of COX1 and COX2, and leads to supressed synthesis of PGE products (Scott, 2012). Kim et al. (2015) reviewed an article on the use of NSAIDs in patients suffering from the common cold. The study found that, apart from relieving headaches, the medication did not have a significant effect on common cold symptoms such as sore throat, myalgia, malaise, cough and nose irritations. Given that NSAIDs may increase the risk of serious cardiovascular thrombotic events, myocardial infraction, stroke, impaired hepatic and renal function, intensive assessment before and after the administration of antipyretic medication should be carried out (Scott, 2012; Kim et al., 2015).

In addition to pharmacological antipyretics, physical antipyretics, i.e. those based on external cooling methods to accelerate heat loss through the skin by conduction, convection or evaporation, have been used for more than a century (Isaacs et al., 1990; Kiekkas et al., 2008; Chiu, 2012; Martin, 2016). A diverse range of external cooling methods, for example air-circulating blankets, water-circulating blankets, clothing removal, tepid sponging, bathing, fanning and providing ice packs, is employed in the clinical environment and can be applied in both moderate fever and hyperthermia. (Saxena et al., 2011; Doyle and Schortgen, 2016). The adverse effects of physical antipyretics include shivering, vasoconstriction, vasospasm of coronary arteries and rebound hypothermia (Kurz et al., 1995; Lenhardt et al., 1999; Axelrod, 2000; Kiekkas et al., 2008; Chan and Chen, 2010; Jevon, 2010; Thompson and Kagan, 2011; Knowlton, 2013; Doyle and Schortgen, 2016; Sessler, 2016). With external cooling being used in cases of refractory fever or when rapid temperature decrease is considered necessary, the administration of antipyretic medication is recommended as the first-line treatment (Jevon, 2010; Scrase and Tranter, 2011; Doyle and Schortgen, 2016). For this reason, it is advised that external cooling is not used alone but only after antipyretic drugs have started to lower the elevated thermostatic set-point. Hence its use is recommended with or after pharmacological antipyretics (Meremikwu and Oyo-Ita, 2002; Kiekkas et al., 2008; Niven et al., 2012a). However, the combination of both pharmacological antipyretics and non-pharmacological antipyretics would encourage shivering (Chan and Chen, 2010; Jevon, 2010; Thompson and Kagan, 2011; Knowlton, 2013; Doyle and Schortgen, 2016; Sessler, 2016). Most external cooling methods can be used without instruction from physicians.

Nurses appear to have more autonomy when administering non-pharmacological antipyretics, especially when they are non-invasive (Herman and Nurshal, 2017). Although physical antipyretics are frequently used in the clinical setting, recent studies have shown that aggressive physical antipyretics do not lower temperature more rapidly than pharmacological antipyretics and the former result in a higher incidence of detrimental effects (Diringer, 2004; Schulman et al., 2005; Kiekkas et al., 2008; Carey, 2010; Hammond and Boyle, 2011). Ice packing, tepid ice packing and tepid sponging are not recommended procedures because they do not produce a sustained drop in temperature and may lead to vasoconstriction (Jevon, 2010; Dai and Lu, 2012; Doyle and Schortgen, 2016; NICE, 2017). Sponging can also cause shivering and can increase the metabolic rate (Foster et al., [no date]; Glasper et al., 2009; Carey, 2010; Scrase and Tranter, 2011; Grainger, 2013; NICE, 2017).

Antipyretics may not only have detrimental effects, but could mask the symptoms of illness. Although management of fever should be provided when a patient is experiencing uncomfortable symptoms, most of the current scientific evaluation of fever addresses the phenomenon from the perspective of research or clinicians (Ames et al., 2013). Ames et al. (2013) explored patients' fever experiences in a qualitative study. The study demonstrated that more than 79% of participants felt cold and weak, these were the symptoms expressed most frequently. The theme 'warm' was reported by 75% of participants and was found to be associated with sweating. It is worth noting that both cold and warmth would only be developed at a certain febrile stage. It would seem that both cold and warmth commonly occurred in fever patients. Another commonly stated symptom was sweating, which occurred in more than 60% of participants. Other symptoms such as non-specific bodily sensation, gastrointestinal symptoms, headache, and emotional changes were reported as well. The three least commonly stated symptoms were hallucination, respiratory symptoms and generalised aches. The paucity of existing literature on antipyretics used to treat these symptoms when associated with fever represents a lack of justification for the administration of antipyretics to fever patients experiencing discomfort (Ames et al., 2013). Hence, the literature review of fever management was carried out to understand how clinicians manage fever and what factors influence their management of fever.

2.4.1 Fever in patients with neurological illness

Up to 70% of patients with a brain injury experience fever (Picetti et al., 2014). Current evidence illustrates that a raised temperature could be life-threatening, especially to patients with a neurological injury. The incidence of fever could lead to higher rates of mortality and mobility, decreased functionality, as well as a longer hospital stay. Moreover, it could elicit further brain injury. A plausible explanation for this is that pyrexia could increase the permeability of the blood–brain barrier to immune cells, and result in cerebral oedema and neuronal death (Pickard and Czosnyka., 1993; Jones et al., 1994; Castillo et al., 1998; Rumana et al., 1998; Schwarz et al., 2000; Stocchetti et al., 2002; Childs et al., 2008; Carey, 2010). The collateral damage of fever in patients with ischemic stroke, haemorrhagic stroke and subarachnoid haemorrhage is well established in the literature. For patients with traumatic brain injury (TBI), the existing evidence of fever effect appears to be controversial. A meta-analysis by Greer et al. (2008) suggests that fever is linked with detrimental effects in patients with TBI. This assertion, however, was challenged by multiple research groups (Childs et al., 2006; Childs et al., 2010; Sacho et al., 2010). It was argued that only extremes of high or low temperature result in increased mortality (Childs et al., 2006; Childs et al., 2010; Sacho et al., 2010). Debate about whether fever would elevate intracranial pressure (ICP) in patients with TBI was also generated (Rockett et al., 2015). A few studies reveal that ICP tends to rise during the febrile response (Rossi et al., 2001; Picetti et al., 2014). However, the results from other studies contradict this observation confirming that no significant relationship between absolute temperature and a rise in ICP has been discovered (McIlvoy, 2007; Huschak et al., 2008). Picetti et al. (2014). These studies also display a significant correlation between the utilisation of antipyretics and decreased ICP, although the significance is only observed at a certain level of ICP. Accordingly, it is uncertain whether there should be an intervention to reduce fever in cases of fever in patients with TBI. Another neurological illness which considered fever could result in harmful effects is meningitis. Only limited number of studies examine the impact of fever in meningitis patients. As a result, no conclusion can be drawn from the current clinical trials.

Published clinical practice guidelines were found for patients with ischemic stroke, haemorrhagic stroke, subarachnoid haemorrhage or TBI (Rockett et al., 2015) and recommend using antipyretics. However, guidelines for patients with TBI, published in 2007, do not refer to fever management at all (Rockett et al., 2015). According to Rockett et al. (2015), 27% of neuroscience registered nurses reported having a neuro-specific protocol for managing patients with elevated temperature. All antipyretics, especially pharmacological antipyretics, though effective in neurological illness, were discovered to have significant negative impact for example hypotension. The prevalence of hypotension could expose patients to risk of further damage to the brain. It was proposed that paracetamol administration for fever control in patients with neurological issues should be monitored and assessed continuously (Picetti et al., 2014).

2.4.2 Fever in children

The definition of fever in a child is different from that in an adult and it mainly depends on the child's age and general health (El-Radhi, 2008). Compared with adults, children are more likely to progress to febrile seizures because the development of their brain is more sensitive to the alteration of temperature. Although febrile seizures are known to affect 2% to 5% of all children suffering from fever, parents are afraid that their child suffering from fever, may develop febrile seizures (Meremikwu and Oyo-Ita, 2002; El-Radhi, 2008; Wong et al., 2013b). Parents often felt that fever may spiral upwards with a possible fatal outcome. As a result, they were convinced that antipyretic measures must be used to lower fever (El-Radhi, 2008). Conversely, the guidance on the management of fever in children advises that antipyretics should not be administrated routinely; instead they should be provided to reduce the patient's discomfort (NICE, 2017). Still, many parents believe that fever can cause brain damage, coma and death, alongside the more common concerns of convulsions and dehydration. Therefore, fever phobia, an exaggerated fear of fever in their children, is relatively common among parents (Richardson and Purssell, 2015).

Given this, fever management is widely used for treating febrile children (Meremikwu and Oyo‑Ita, 2003). Evidence examining a range of methods for treating fever in children has been reviewed. Studies show no significant differences between different antipyretic medications (Wong et al., 2013b). As for physical cooling techniques, research indicates that compared with antipyretic medications, physical cooling can produce a greater drop in temperature, especially when using ice water bathing and tepid sponging. The fall in temperature was even larger when both antipyretic medication and physical cooling were used. However, studies only investigated the effect of intervention in the first 2 hours after administrating antipyretics (Meremikwu and Oyo‑Ita, 2003). Despite the effectiveness in subsiding febrile episodes, adverse events were statistically significantly higher when performing physical cooling methods compared with pharmacological antipyretics (Meremikwu and Oyo‑Ita, 2003). It was reported that non-pharmacological antipyretics such as tepid sponging intensify the risk of shivering and discomfort (Meremikwu and Oyo‑Ita, 2003; Jevon, 2010; Chiu, 2012). To conclude, it seems that there is insufficient data to support the effectiveness of non-pharmacological antipyretics in children, while there is reliable evidence from clinical trials to demonstrate the negative impact of physical cooling, especially iced water sponging and tepid sponging. Consequently, most practice guidelines stipulate that tepid sponging and iced water bathing should not be applied to patients with fever (Jevon, 2010; Dai and Lu, 2012; Doyle and Schortgen, 2016; NICE, 2017).

2.4.3 Fever in cancer patients

Research on fever in patients after treatment for cancer has mainly focused on the management of infection. Since cancer treatments such as radiotherapy, chemotherapy, immunotherapy, targeted therapy and transplants are generally devastating to the human body, fever often occurs following these treatments as an inflammatory response to activate the immune system (Ogawara et al., 2016). Furthermore, tumours themselves increase a patient’s susceptibility to infection through obstructive processes and the destruction of anatomic barriers (Toussaint et al., 2006). Hence, infections are frequently the cause of fever in patients with oncological disorders, accounting for about 50% of fever cases. Possible non-infectious causes of fever that require fever treatment make up about 25% of fever cases, while about 10% of fever cases are induced by the tumour itself. Neutropaenic fever amounts to 50% of all infection-derived fever (Toussaint et al., 2006; Ogawara et al., 2016; Pasikhova et al., 2017). Neutropaenic fever is fever in a patient suffering from neutropaenia, which is usually defined as a deficiency in absolute neutrophil count. The paucity of neutrophils weakens a patient’s immune system making them more vulnerable to infection (Pasikhova et al., 2017). Assessing the risk of neutropaenia, the risk of complications from neutropaenic fever, and the risk of sepsis is mandatory and should be done promptly. The management of fever in cancer patients, accordingly, is different to that in other fever patients. It includes the use of antimicrobial medication and granulocyte colony-stimulating factor (G-CSF) (Klastersky, 2004; Sipsas et al., 2005; Bow and Wingard, 2013; Bow, 2018). Guidelines for the management of neutropaenic fever and fever in patients with oncological illness have existed for more than two decades. These well-established guidelines can assist clinicians in their decision making about the optimal regimen for fever patients with cancer (Sipsas et al., 2005).

Following the discussion above, the literature review of fever management excluded fever in neurological, paediatric and cancer patients, because these areas have different approaches to the management of fever. In addition, literature on fever related to infectious disease, such as dengue fever and Ebola virus, was also left out of the review because the guidelines for those diseases are specific and different from fever in general. However, fever caused by other diseases, such as post myocardial infarction or immune diseases, were not included, because there were no published articles about knowledge and management of elevated temperature in those diseases. Most of the articles in those diseases were based on case study or epidemiology.

All relevant articles about nurses’ fever management were searched. The databases yielded 33 full-text articles. Among the 33 articles, 17 were research articles, 10 were literature reviews and 6 were studies associated with sepsis. There were 16 articles describing fever in a critical-care setting, while 17 studies were based in non-critical environments.

2.4.4 Fever management in non-critically ill patients

The process of fever is complex and there is no agreed consensus about whether to manage moderate fever. The cost of pyrexia should be considered from several perspectives. If and when it is decided to treat fever there are a variety of management methods available with no consistent clinical standard or reliable published evidence to support their use (Hammond and Boyle, 2011). The literature review of fever management aims to identify current evidence and practice about fever management. The 17 articles identified from non-critical care environments consisted of 4 review articles (Carey, 2010; Eyers et al., 2010; Jevon, 2010; Scrase and Tranter, 2011) and 9 research articles. Of the 9 research articles, 4 were observational studies (Mohr et al., 2011; Mohr et al., 2012; Yokobayashi et al., 2013; Yoo et al., 2017), 3 were experimental research studies (Schortgen et al., 2012; Karam et al., 2014; Russo et al., 2014) and 2 surveys (Chiu, 2012; Yamada et al., 2017). Fever in sepsis was explored in 3 of the articles (Mohr et al., 2011; Mohr et al., 2012; Schortgen et al., 2012).

Arguments about whether less intervention is better for fever patients continue. Nevertheless, the fear of fever leads most doctors and nurses to treat fever (Carey, 2010; Richardson and Purssell, 2015). Carey (2010) carried out a literature review to understand whether the practice of routinely treating fever was supported by the available evidence. The results from the literature showed that the latest evidence was not generally applied in clinical practice. While some studies implied that antipyretic medication could prolong illness (Schulman et al., 2005; Carey, 2010; Dai and Lu, 2012), other studies state that pharmacological antipyretics did not affect the duration of illness (Kim et al., 2015). Interestingly, none of the studies revealed that antipyretics shortened the length of the febrile episode as well as the period of illness. Besides pharmacological antipyretics, the evidence showed that non-pharmacological antipyretics should not be employed alone, as the overwhelming drop in body temperature caused by physical cooling could intensify shivering and eventually increase the metabolic rate as well as the patient's discomfort (Gozzoli et al., 2004; Carey, 2010; Hammond and Boyle, 2011; Richardson and Purssell, 2015). The majority of evidence and guidelines suggest that methods to manage pyrexia should not be routinely administrated. It was concluded that interventions for fever should be used selectively, and the reasons for administering antipyretics should be clearly identified (Carey, 2010; Jevon, 2010; Scrase and Tranter, 2011; Nazarko, 2014).

Chiu (2012) designed a survey to investigate clinicians' fever management in Taiwan. It was found that the most popular antipyretic medication was paracetamol, followed by NSAIDs including ibuprofen. Aspirin was the third most commonly prescribed medication. The study also researched the rationale for clinicians in managing fever. More than 70% of clinicians chose 'to prevent increased metabolic demands' as their primary rationale for administering antipyretics. This was also the top reason for doctors to prescribe antipyretics, while 87% of nurses gave relieving patients' discomfort as their main reason for managing pyrexia. The third most popular reason for nurses (63%) to intervene was purely aimed at reducing body temperature. More than 50% of doctors also indicated that lowering body temperature was their primary reason. Other concerns, that more than half of the nurses considered when managing fever, included the danger of febrile seizures and neurological damage. On the other hand, more than half of the doctors selected anxiety around fever from both patients and carers as their primary reason for prescribing antipyretic medications. Interestingly, approximately 75% of nurses thought that without intervention, patients with pyrexia would be dehydrated, while 50% of nurses assumed that without fever management, pyrexia patients would be likely to develop febrile seizures. However, the study did not look at non-pharmacological antipyretics. It was reported that the average temperature for clinicians to initiate fever management was 38.2°C, while the average temperature for clinicians to withdraw interventions from fever patients was around 37.3°C to 37.9°C. Although numerous fever management methods were listed, studies were lacking on the optimal febrile range or the temperature threshold at which antipyretic therapy was initiated. Accordingly, a study conducted by Russo et al. (2014) evaluated whether the implementation of fever practice guidance could shorten the length of the hospital stay and illness of patients. It was found that the standardised fever management helped to reduce both the cost and time of treatment by over 60%. This result showed a positive impact on the outcome for fever patients. However, the study did not give details of the guidance.

Research investigating factors that influence fever management and the outcomes of managing fever was conducted on patients with sepsis. Mohr et al. (2011) conducted a retrospective cohort study to analyse the use of antipyretics in patients with gram-negative sepsis. Among all 241 fever patients, 76% received antipyretics. Patients' demographic data, hospital stay, and their type of illness were examined to see if any were affected by the administration of antipyretics. It was discovered that the severity of the illness, demographic factors and treatment of the disease, for example the use of antibiotics, were not associated with the administration of antipyretics. It seems that the provision of antipyretic therapy very much depended on the individual clinician's thoughts. The study hypothesised that the clinician's decision-making process might be key in determining the necessity for antipyretic therapy. Another study, also conducted by Mohr et al. (2012), explored the impact of fever interventions on mortality when administered early in gram-negative septic shock patients. It was revealed that the group of patients who received early antipyretic medication had a lower mortality rate. However, early antipyretic administration was not significantly related to 28-day, in-hospital mortality. Likewise, a multicentre randomised controlled trial in patients with sepsis studied the impact of physical cooling methods used to reduce fever (Schortgen et al., 2012). The external cooling was shown to be effective in reducing body temperature after 2 hours of treatment. In addition, the vasopressin dosage was significantly reduced in patients who received external cooling after 12 hours of treatment, with no rebound effect observed. A significant reduction in 14-day in-hospital mortality was also noted. The study concluded that external cooling was safe and could give septic patients a better outcome, unlike the negative effects discussed in other studies. The physical cooling accelerated haemodynamic stabilisation, decreased vasopressor requirements, reduced the duration of septic shock and decreased early mortality. In spite of this, throughout the whole article, the details about the precise methods of external cooling were absent. The overall evidence shows that there are still inconclusive findings about the effect of antipyretics in febrile patients with sepsis, and the most important factor that influences fever management in sepsis is the clinician's own decision-making process

Karam et al. (2014) and Yoo et al. (2017) both performed studies on postoperative fever. Karam et al. (2014) observed the use of analgesics in patients who underwent total joint arthroplasty in a controlled trial. There were a control group, which received an opioid-based perioperative pain management protocol and a multimodal group, which received a non-opioid based pain management protocol consisting of acetaminophen, celecoxib, and pregabalin. The results showed that compared to patients who had only opioid-based pain management, patients who had multiple analgesics as a pain control protocol were less likely to develop fever. Infection was found in around 38% of the febrile patients in both groups. However, the multimodal group had slightly higher infection rates. Moreover, the workup results showed that the control group had a statistically significant higher positive rate in urinalysis. Another study on elderly patients who had surgery for fractured neck of femur revealed that 77% of patients had a febrile episode before the second post-operative day (Yoo et al., 2017). About 50% of the patients developed multiple fever spikes. For that reason, almost every patient who developed fever received a diagnostic fever workup after surgery. Interestingly, among all the workups, less than 15% yielded a positive result for infection (Yoo et al., 2017). It would seem that pyrexia occurs frequently in postoperative patients within 2 days of surgery and most of the fever was not attributed to infection. It was implied that the application of analgesia could mask the fever.

In a long-term care setting, Yamada et al. (2017) examined the factors that affected the initial fever assessment by caregivers. It was found that the severity of fever and comorbidity were the top two factors identified by the caregivers, while institutional policy was the third. Surprisingly, the family's preference was rated as the fourth vital factor that would influence a caregiver's fever assessment. Another study evaluating fever management in patients receiving home medical care in Japan illustrated that, over a year, more than 40% of participants developed fever, with most of the fever patients being diagnosed with pneumonia or bronchitis, urinary tract infections, and skin or soft tissue infections (Yokobayashi et al., 2013). The study stated that there was no significant correlation between fever patients' use of medication, such as steroid medication or anticancer drugs, and the incidence of fever. Almost 80% of febrile patients had fever that subsided at home. However, the study did not explain the process used to reduce pyrexia or the management of febrile patients.

A meta-analysis by Eyers et al. (2010) was based on animal models. The review analysed the literature on the effects of antipyretics with influenza. It concluded that there was a significant correlation between the use of antipyretics and an increased risk of mortality. However, all the studies used animal models and there was no randomised controlled trial of the effects of fever management on the mortality of influenza patients (Davis et al., 1985; Crocker et al., 1998; Sunden et al., 2003). Most influenza virus infections in humans are temperature sensitive. Therefore, potential mechanisms exist whereby controlling fever temperature might lead to an increase in mortality rates. For example, temperatures in the range of 38°C to 41°C have been shown to inhibit the replication of RNA in influenza A, consequently controlling fever could allow an increased rate of viral replication. Similar evidence has been discovered in patients infected with Streptococcus pneumonia strains (Dalton et al., 2006). Holtzclaw (2013) reviewed the literature on patients infected with the human immunodeficiency virus (HIV). The review stated that management of fever in HIV patients was similar to that in fever patients without HIV, this included an assessment of body temperature, fluid loss, febrile stage and the patients' level of discomfort. It was advised that the aim of fever management was to resolve patients' distress. In spite of this recommendation for fever management, a case study found that fever phobia among nurses persisted (Holtzclaw, 2013). The above two reviews on fever in patients with viral infections show that fever is an advantageous response, which might have a survival benefit during infection. Additionally, it seems that fever phobia persists in nurses and this could potentially cause the dichotomy between current evidence and clinical practice.

The current advice for the care and management of febrile patients is to monitor and record vital signs frequently, offer sufficient nutrition and fluids to avoid dehydration, provide a comfortable environment, maintain oral hygiene to keep the mouth moist, and only administer antipyretics when needed, but not with the sole aim of reducing body temperature (Jevon, 2010; Scrase and Tranter, 2011; Richardson and Purssell, 2015).

According to Yokobayashi et al. (2013) and Yamada et al. (2017), fever is commonly observed in every type of illness, however, not always with an associated infection (Carey, 2010; Yoo et al., 2017). The literature supporting fever management is inconclusive. While the study of patients with gram-negative sepsis suggests that the use of pharmacological antipyretics has no significant correlation with increasing or decreasing early mortality (Mohr et al., 2012), a study on septic fever shows that external antipyretics could reduce the length of sepsis and reduce mortality (Schortgen et al., 2012). However, neither study mentions which antipyretics were provided or how they were applied. It is also noted that antipyretics might increase both mortality and the duration of the illness (Carey, 2010; Eyers et al., 2010; Holtzclaw, 2013). Among all the approaches to fever management, paracetamol is the treatment most commonly provided (Chiu, 2012). The administration of antipyretics was not correlated with the severity of illness, the patient's demographic data or the treatment of disease. It was also noted that the clinician's individual preferences have the greatest influence on decisions regarding antipyretic administration (Mohr et al., 2011). This result contrasts with the study conducted by Yamada et al. (2017), which indicated that the severity of illness and comorbidity are the top two factors that impact caregivers' fever management. Chiu (2012) also surveyed the rationale of nurses' decision making and highlighted that their main reason for controlling fever was to relieve patients' discomfort. Nurses believed that without administering antipyretics, patients with fever would suffer from dehydration and develop febrile seizures. Both Yamada et al. (2017) and Chiu's (2012) studies showed that more than 40% of participants provided antipyretics to reduce patients' anxiety. Additionally, both of these studies used questionnaires to evaluate clinicians' decision making in fever management; however, it is debatable whether the choices in the questionnaire adequately represented clinicians' decision making.

Similarly, the fear of fever was discussed in several studies. It would seem that the fear of fever would make a clinician more in favour of controlling elevated temperature. As a result, when encountering fever patients, the fear would trigger clinicians to decide to treat the fever symptom (Jevon, 2010; Chiu, 2012; Holtzclaw, 2013; Purssell and Collin, 2016; Yamada et al., 2017). However, these studies did not investigate the reasons for fever phobia or what underpinned participants' fear of fever.

2.4.5 Fever management in critical-care settings

The search for literature on fever management identified 18 articles relating to patients in critical care or ICU. Of these 18 articles, 8 were literature reviews (Kiekkas et al., 2008; Polderman and Herold, 2009; Hammond and Boyle, 2011; Niven et al., 2013; Kiekkas et al., 2013; Young and Saxena, 2014; Doyle and Schortgen, 2016; Long and April, 2017), 5 were observational studies (Kiekkas et al., 2010; Çelik et al., 2011; Lee et al., 2012; Krajčová et al., 2013; Zhang et al., 2015), 3 were randomised controlled trials (Niven et al., 2013; Janz et al., 2015; Young et al., 2015) and 2 studies evaluated fever management in ICU patients (Çelik et al., 2011; Saxena et al., 2011).

Compared with patients in non-critical care, ICU patients were more likely to experience pyrexia. Fever occured in about 70% of ICU patients (Kiekkas et al., 2008; Çelik et al., 2011; Hammond and Boyle, 2011; Niven et al., 2012). In about 50% of those patients the fever was caused by infection (Niven et al., 2012). Other causes of fever were pulmonary embolism, trauma, surgery, drug reaction, cardiac failure, gastrointestinal illness and brain injury, and all these conditions were seen amongst critically ill patients (Polderman and Herold, 2009; Çelik et al., 2011). It seems that the ratio of non-infectious to infectious aetiologies is equal in ICU patients with fever (Polderman and Herold, 2009; Çelik et al., 2011). As previously described in Section 2.2.3, both beneficial and detrimental effects of the process of temperature elevation in fever have been noted. Despite the benign cost of fever, the raised metabolic demand could potentially burden critically ill patients, as they might not be able to cope with the increased metabolic demands. Metabolic rate primarily increases during the chill phase of fever, and is usually accompanied with reduced cardiac output and minute ventilation (Bay et al., 1968; Gautier et al., 1989; Frank et al., 1993; Schmied et al., 1996; Kim et al., 1998; Hart et al., 2011; Scrase and Tranter, 2011; Kiekkas et al., 2013; Knowlton, 2013; Young and Saxena, 2014). Moreover, an observational study conducted by Kiekkas et al. (2010) highlights a positive association between the incidence of fever and the patient's level of agitation. The established evidence also shows that prolonged fever might be correlated with increased mortality (Niven et al., 2013; Kiekkas et al., 2013; Zhang et al., 2015). This could indicate that, compared with fever patients in non-critical-care settings, ICU patients with fever are more likely to develop adverse effects. On the other hand, some evidence suggested that fever was significantly associated with a decrease in mortality (Leroy et al., 2009). A similar outcome is presented in other studies of patients suffering from infectious or non-infectious illness (Lee et al., 2012; Young et al., 2012). Furthermore, there was found to be a positive relationship between ICU patients with infection who fail to manifest fever and increased mortality (Young et al., 2012; Kiekkas et al., 2013). Thus, the pros and cons of the administration of antipyretics should be considered. It was noted that antipyretics were commonly administered to ICU patients with fever (Young et al., 2011; Lee et al., 2012). However, the question remains of whether pyrexia should, or should not, be treated. Current evidence lacks robust data on how and when to intervene with the management of fever, and the evidence there is offers conflicting advice for best practice (Doyle and Schortgen, 2016).

Multiple sources have demonstrated the efficacy of antipyretics (Çelik et al., 2011; Niven et al., 2013; Kiekkas et al., 2013; Long and April, 2017). Both pharmacological and non-pharmacological antipyretics were given to about 50% of ICU patients with fever. However, the debate on whether or not fever in ICU patients should be controlled is ongoing. One meta-analysis found that interventions for sepsis associated fever correlated with a reduction in 14-day mortality (Long and April, 2017), while in contrast, other studies revealed that fever management does not reduce mortality (Niven et al., 2013; Lee et al., 2012; Long and April, 2017). A study performed by Zhang et al. (2015) showed that the administration of antipyretics was associated with increased mortality. Compared with non-ICU patients, different types of antipyretics were used more often in ICU patients. The effects of pharmacological antipyretics including paracetamol, NSAIDs and aspirin were examined in a number of studies. Three randomised controlled trials on febrile patients in ICUs demonstrated that there was no statistical difference in the outcome between those managed with paracetamol and those who received no management at all (Niven et al., 2013; Janz et al., 2015; Young et al., 2015). It is worth noting that a study carried out by Janz et al. (2015) investigated ICU fever patients with severe sepsis. The research team found that use of acetaminophen, which is called paracetamol in the UK, during fever could improve renal function. However, the research team suggested that further study with larger sample sizes and heterogeneous patient populations was warranted. Another study showed that acetaminophen increased 28-day mortality in septic patients (Lee et al., 2012), but there was no correlation in non-septic patients (Lee et al., 2012). A literature review conducted by Kiekkas et al. (2013) showed the same results, whereas a literature review by Niven et al. (2012a) identified a risk of increased mortality in patients who received paracetamol to control fever (Schulman et al., 2005). Most studies suggest that there is no correlation between the administration of antipyretics and a decreased length of stay in an ICU (Young et al., 2015). Although one of the primary side effects of paracetamol is hepatotoxicity, studies demonstrated no significance association between adverse liver function and patients who received paracetamol (Niven et al., 2013; Janz et al., 2015; Young et al., 2015; Zhang et al., 2015). Side effects of paracetamol were recorded by Krajčová et al. (2013), who discovered that paracetamol might induce hypotension ($p<0.001$) through a reduction in cardiac output and systemic vascular resistance. Among all articles on the use of acetaminophen in fever patients, only one mentions the advantages of using this drug (Janz et al., 2015). It is significant that acetaminophen could reduce creatinine levels. As well as paracetamol, NSAIDs were equally popular for managing pyrexia (Lee et al., 2012). The literature review showed that NSAIDs were the most effective pharmacological antipyretics in reducing fever. Nevertheless, although the NSAIDs appeared effective in the descriptive statistics, there was no statistically significant difference between patients taking NSAIDs and patients taking a placebo (Bernard et al., 1997; Jefferies et al., 2012; Niven et al., 2012; Young and Saxena, 2014), while an observational study indicated that NSAIDs were associated with an increased 28-day mortality in patients with sepsis (Lee et al., 2012). Another antipyretic medication, aspirin, is rarely evaluated in fever patients with critical illness. Research on the use of aspirin to control fever has only been conducted in animals where it was found to significantly increase the risk of death (Jefferies et al., 2012; Young and Saxena, 2014). However, the possible explanation that aspirin might increase the risk of death was not established in the articles. The above evidence regarding antipyretic drugs presents no consensus of opinion.

In addition to pharmacological antipyretics, non-pharmacological antipyretics are also used frequently in ICU fever patients. Physical cooling methods are usually performed when antipyretic medication has a limited response in reducing fever or are usually given with pharmacological antipyretics. Zhang et al. (2015) state that external cooling had a significant correlation with increased mortality. Nevertheless, Lee et al. (2012) demonstrate that physical cooling did not have a significant effect on mortality rates or length of illness. These results were supported by other researchers (Kiekkas et al., 2008; Hammond and Boyle, 2011; Niven et al., 2013; Doyle and Schortgen, 2016). However, the majority of the articles discussing physical cooling methods do not give details about the technique used or how it was applied. A few studies compare aggressive fever management with permissive fever management. In these studies, aggressive fever management is defined as being regularly provided with acetaminophen, and if the temperature continues to elevate, then physical management is performed. For permissive fever management, no treatment is offered until the body temperature reaches hyperthermia. In these studies the aggressive fever management was significantly more effective in lowering body temperature; however it also led to increased mortality (Hammond and Boyle, 2011; Kiekkas et al., 2013; Young and Saxena, 2014). Conversely, the study conducted by Niven et al. (2013) demonstrated a different result. It showed no significant difference between aggressive fever management and permissive fever management in the outcome. However, this study had a small sample size and it is debatable whether they are representative of the population of fever patients in ICUs.

Two of the studies investigated the application of fever management (Çelik et al., 2011; Saxena et al., 2011). The study conducted by Çelik et al. (2011) looked at the medical records of 53 fever patients and analysed the data. The results showed that the most common intervention for fever patients was the administration of antipyretic medication (69.8%). The second most popular fever management was ice application and tepid water baths; while 62.3% of patients received both treatments. This Turkish study stated that among all pharmacological antipyretics, the most frequently used was metamizole sodium, which was given to 51% of participants. This medication, however, is prohibited in many countries including the USA, Japan, Australia, Iran, Sweden India and the UK, due to its side effect of agranulocytosis. It was also noted that 48.6% of patients received acetaminophen as an antipyretic, while 18.9% of participants had paracetamol. Nevertheless, it is arguable whether the results of the study are reliable, because paracetamol and acetaminophen are the same product with different names. The study showed that physical cooling, often employed for ICU fever patients, presented a similar result. More than 60% of fever patients received physical cooling during the fever episode. This study used a survey to examine the attitudes of ICU clinicians in Australia and New Zealand towards fever management of patients with sepsis but without neurological injury. The survey was completed by 447 clinicians working in critical care units. Among all participants, 308 were nurses (69%), 137 were doctors (31%) and there were 2 others. Most of the participants (80%) indicated that the temperature for them to initiate pyrexia management was 39°C. Through correlational analysis it was found that nurses preferred to administer antipyretics at lower temperatures than doctors (Saxena et al., 2011). The result was the same as that from a survey conducted by Chiu (2012), although Chiu's study was not limited to ICU clinicians, but to all clinicians working in the hospital. In a study by Saxena et al. (2011), the most popular fever management, again, was paracetamol. About 85% of respondents chose this as their first-line intervention to treat fever. As well as antipyretic drugs, physical cooling methods were commonly used. For example, 56% of participants first removed the patient's clothes when treating a febrile patient; 29% of respondents used a fan as their first-line antipyretic, and 27% of participants used tepid sponging on fever patients. More than 55% of participants used both pharmacological and non-pharmacological antipyretics. The result of the frequent use of physical cooling methods echoes the findings of the study by Çelik et al. (2011). As for the second-line antipyretic interventions if fever persisted, again, paracetamol was the most popular pharmacological antipyretic used (Saxena et al., 2011). It is also worth noting that more than 50% of nurses would consider administrating cold intravenous fluid and a cooling blanket to reduce body temperature. Apart from paracetamol, other types of antipyretic medications were rarely considered. The results also show that, compared to doctors, nurses showed a significant preference for using physical cooling techniques alone. However, one of the limitations of the study was that the survey might not truly reflect clinicians' fever management in the clinical setting, as the options in survey may be different from those available in the clinical setting (Saxena et al., 2011). Zhang et al. (2015) investigated the rationale of performing antipyretic interventions. The study did not clearly determine clinicians' reasons for administering antipyretics. Evidence examining the rationale of fever management was lacking.

In conclusion, the synthesis of the review sources would suggest that there is no consensus about whether fever is beneficial or detrimental to the patient. While some studies imply that fever can lead to increased mortality (Niven et al., 2013; Kiekkas et al., 2013; Zhang et al., 2015), others suggest that patients who develop fever have a lower mortality (Lee et al., 2012; Young et al., 2012;

Kiekkas et al., 2013). Nonetheless, fever is considered to create a burden for patients in critical care. This is mainly because an elevated temperature increases the metabolic rate and ICU patients might not be able to compensate. Agitation was also discovered to have a significant relationship with the incidence of fever in patients (Kiekkas et al., 2010; Doyle and Schortgen, 2016). Antipyretics, both pharmacological and non-pharmacological, were frequently provided for ICU patients with fever (Çelik et al., 2011; Saxena et al., 2011; Niven et al., 2013; Janz et al., 2015; Young et al., 2015). Yet, inconclusive findings about the administration of antipyretics were noted. Some evidence proposes that the application of antipyretics could be harmful (Kiekkas et al., 2008; Zhang et al., 2015), while the majority of the literature reveals that antipyretics do not have a statistically significant correlation with the length of hospital stay, ICU stay or mortality (Niven et al., 2013; Janz et al., 2015; Young et al., 2015). Administration of antipyretic medications is the most popular first-line fever management in the ICU. About 50% of ICU patients with a febrile status are offered antipyretic drugs. Surprisingly, more than 50% of fever patients in the ICU also receive non-pharmacological antipyretics (Çelik et al., 2011; Saxena et al., 2011). This also indicates that it is usual to administer antipyretic medication alongside physical cooling to fever patients in critical care. Nevertheless, there is a paucity of evidence focused on the febrile range that clinicians tolerate, as well as on the rationale for fever management (Russo et al., 2014; Zhang et al., 2015).

2.5 Summary

A total of 33 articles were found in the field of fever management, but only 10 of these met the aim of investigating nurses' knowledge of fever. It showed that infectious and non-infectious diseases observed in the clinical environment caused an equal number of incidents of fever (Carey, 2010; Yoo et al., 2017). Fever is not only one of the vital signs but also an important factor to consider when risk assessing the procedures for managing certain conditions such as systemic inflammatory response syndrome (Singer et al., 2016). Fever is a very common symptom seen in the clinical setting, especially in the critical-care setting (Hammond and Boyle, 2011; Yokobayashi et al., 2013; Yamada et al., 2017). Pyrexia can be of benefit to the patient during the life cycle of a disease. On the other hand, it can also present patients’ immune systems with daunting metabolic challenges. It is, therefore, important for nurses to know how to deal with the symptoms of fever and know whether active management would be harmful or not (Carey, 2010; Jevon, 2010; Scrase and Tranter, 2011; Nazarko, 2014). However, most of the articles investigating the fever knowledge of nurses were in the area of paediatrics, and knowledge deficits appeared in every study. It was illustrated that nurses’ knowledge of fever physiology, management and antipyretics was relatively low (Scrase and Tranter, 2011). Studies investigated the factors that were associated with the level of fever knowledge, only past experience had a significant correlation with fever knowledge. It seems that the more experience a nurse has, the more fever knowledge they will gain. Other factors were not found to have a significant relationship with the level of fever knowledge (Chiu, 2012; Greensmith, 2013; Kiekkas et al., 2014; Baran and Turan, 2018). As well as fever knowledge, most of the articles examined clinicians’ attitudes towards fever with a Likert scale. It is questionable whether a study investigating attitudes towards fever will have an influence on responses to questions about fever knowledge. Through the investigation into fever knowledge it was found that, because nurses fear fever (Greensmith, 2013; Purssell and Collin, 2016), they tend to manage fever in every situation. However, evidence shows that educational programmes have a significant impact on changing clinicians’ attitudes towards fever management (Scrase and Tranter, 2011; Brick et al., 2017).

The debate about whether antipyretics increase mortality or the length of hospital stay is ongoing. The majority of evidence suggests that there is no significant correlation between the administration of antipyretics and mortality for in-hospital stays (Niven et al., 2013; Janz et al., 2015; Young et al., 2015). Existing evidence on antipyretic treatment, although inconclusive, is far from advocating practices of controlling fever. Most of the studies agree that patients with an infectious disease who fail to develop fever have a higher risk of mortality (Young et al., 2012; Kiekkas et al., 2013). Fever in a critical-care setting was found in many studies. It is hypothesised that the metabolic demands of fever might be excessive for ICU patients. However, the evidence shows contradictory results and no conclusion has yet been made. Only three studies investigated what kind of fever management was regularly applied in the clinical setting (Çelik et al., 2011; Saxena et al., 2011; Chiu, 2012). Pharmacological antipyretics were the first-line choice for clinicians, with paracetamol being the most popular method used to manage fever. Surprisingly, physical cooling methods were often provided as first-line fever management as well as medication, especially in the critical-care setting. A plausible reason for this could be that clinicians tend to intervene more with fever in ICU patients than with non-ICU patients Therefore, physical cooling methods were usually employed to ensure that the elevated temperature was controlled (Chan et al., 2010; Çelik et al., 2011; Saxena et al., 2011; Niven et al., 2012a; Schortgen et al., 2012; Zhang et al., 2015). Chiu's (2012) study did not assess the use of non-pharmacological antipyretics; while the other two studies also had limitations to study the use of non-pharmacological antipyretics, such as a small sample size (Çelik et al., 2011; Saxena et al., 2011). Additionally, there is a paucity of evidence on the febrile range that clinicians tolerate before intervening, and on the rationale for fever management (Russo et al., 2014; Zhang et al., 2015). The absence of explicit evidence on the purpose of providing antipyretics is noted. Studies debate how various factors such as the severity of illness, patients' demographic data and the treatment of disease could impact clinicians' fever management (Mohr et al., 2011; Yamada et al., 2017). Chiu's (2012) study highlights that it is the analgesic properties rather than the temperature-lowering action of antipyretics that mainly accounts for improvements in patients' comfort. It is argued whether the studies that used a multiple-choice questionnaire truly reflect clinicians' decision-making processes. As a result, the literature review enabled the identification of gaps between the available evidence and the clinical practice of fever management at the patient's bedside. In the absence of conclusive data, the approach to fever management should be based on the decision-making process of clinicians'. This evidence prompted the need to investigate the factors that influence nurses' clinical behaviour in managing fever.

CHAPTER THREE: DESIGN AND METHODOLOGY

3.1 Introduction

In this chapter the research aim and objectives are revisited to demonstrate the link with the research design. The research paradigm is presented to explain the methodology applied in this study. A mixed method design was adopted based on a questionnaire and interviews. The choice of process used for data collection and eligibility criteria is discussed in Section 3.4 below. The design of the questionnaire and the interview are outlined followed by an explanation of the tools used to organise and distribute the study materials. The use of the mixed methods approach is justified. Given the complexity of this approach, a two-stage analysis was used. This finally allowed the results of both methods to be woven together. Finally, ethical considerations connected with the research, the review process and the researcher's recognition of potential risks and harm, are discussed and the limitations of the research design are specified and explored.

3.2 Research aim and objectives

This research aimed to understand how nurses use knowledge of fever in their clinical decisions on pyrexia-related nursing interventions to manage adult patients' fever.

The objectives of this research were as follows:

- To understand nurses' decision-making process in the management of fever
- To explore how knowledge acquisition influences nurses' decisions in the management of fever

- To identify factors that influence the knowledge acquisition in the management of fever.

3.3 Research design

3.3.1 Research paradigm

The research questions focused on the ontology as well as the epistemology of fever. The term ontology denotes 'the nature of what is investigated' (Hirschheim et al., 1995: 20). The ontological perspective adopted in this research is 'post-positivism'. Positivists adhere to the view that only factual knowledge gained through observation, including measurement, is trustworthy. That is, they are quantitative purists who believe that social observations should be treated as entities in much the same way that physical scientists treat physical phenomena. As a result, positivism limits the data collection and interpretation to objective facts, this is usually termed the quantitative method (Aliyu et al., 2014; Bryman, 2016). Unlike positivism, post-positivists advocate the use of a more complex research design. They are also cautious regarding strong and one-sided interpretations and restrained in the use of quantitative data and methods (Clark, 1998; Adam, 2014; Aliyu et al., 2014). Accordingly, post-positivism has three principal concerns regarding the conduct of research, 1) the quality of the data, 2) the use of an integrated approach, and 3) the context of the phenomena under study (Adam, 2014). In this study the researcher adopted a post-positivist approach in order to obtain a richer understanding of what nurses know about fever and how they deal with fever patients compare with quantitative approach only.

Epistemology means "all the nature of human knowledge and understanding that can possibly be acquired through different types of inquiry and alternative methods of investigation" (Hirschheim et al., 1995: 20). It seeks to offer guidance on how and what we should know, based on how and what we actually know (Faubion, 1994; Fuller, 2007; Bryman, 2016). The present research chose 'rationalism' as its epistemology. Rationalism is the view that all or most truth is deductive in nature and derived logically from a set of axioms obtained by intuition or inherent knowledge (and not from studying the world around us empirically). Such concepts cannot be acquired by experience, but are a precondition for any experience (Faubion, 1994; Fuller, 2007; Faludi, 2017). The method favoured by rationalists is to reduce any problem to those factors that cannot be questioned, i.e. to evident statements. From this starting point, the evident statements may be combined and new knowledge may be deduced. Rationalism involves a ‘top‐down’ analysis in the processing of information, also known as deductive reasoning (Evans, 2013; Johnson‐Laird, 2006). Both post-positivism and rationalism provide reliable foundations for knowledge, which for the rationalist offer successful ways of reconciling a paradigm (Plowright, 2011). While post-positivists are concerned about the reliability of the data, rationalists consider the foundations of true belief to be driven by reason and logic in the production of knowledge (Plowright, 2011).

This study was designed, firstly, to understand the fever knowledge that nurses possess and, secondly, to understand the dynamics of how nurses manage fever in different clinical contexts. In keeping with post-positivism and rationalism, the study design began with a survey to assess both the nurses’ knowledge and their management of fever. The survey explored the detailed and concrete knowledge of how nurses understand and deal with fever. Semi-structured interviews were conducted with selected participants in order to obtain a more in-depth understanding and explanation of the relationship between the nurses’ fever knowledge and their fever management.

3.3.2 Measuring knowledge of fever

Knowledge is a very broad term and it cannot be observed directly. The most common and efficient way of measuring an individual’s knowledge is by using the survey method (Borgatti and Carboni, 2007; Saris and Gallhofer, 2007). The measurement of knowledge by standardised tests is a well-developed sub-discipline of education and psychology, dating back to the early 20th century. For this purpose, knowledge is translated into a set of propositions to be presented to the respondents, who are asked to decide if they are true or false by answering a series of multiple choice or other questions (Borgatti and Carboni, 2007; Saris and Gallhofer, 2007; Stopher, 2012). The disadvantages of self-administered questionnaires, e.g. participants might not truthfully answer the survey or they might misunderstand the questions or options, can reduce the reliability of the survey for research (Oppenheim, 2001; Hunt, 2003; Sapsford, 2007). It is also essential that the researcher conducts a pilot study to ensure the reliability and validity of the questions before distributing the questionnaire.

3.3.3 Understanding nurses' management of fever

Various research methods are available for understanding the interventions that nurses use in clinical practice when managing a fever patient. Direct observation is the most reliable way of recording what is really happening in the clinical setting (Oppenheim, 2001; Sapsford, 2007; Hutchinson and Johnston, 2008; Curtis and Drennan, 2013). However, in conducting a direct-observation study, certain complex issues arise, such as negotiating ethics, gaining access and knowing where to sit in relation to the nurse and patients (Gillham, 2008; Parahoo, 2014). Also, fever symptoms can be recurrent and may take time to subside and manage. Hence, using direct observation as a method to study fever management can be time-consuming and require the hiring of another researcher, adding to the cost of the study.

The most important issue is that making direct observations or asking patients questions may unnecessarily increase a patient's burden (Ulrich et al., 2005). The principle of respect for persons is frequently articulated when considering their rights. Such rights include the right not to be injured or mistreated; the right to give informed, un-coerced consent to participate in the research and the right to privacy, confidentiality and anonymity. As to protecting the participant's right not to be harmed or mistreated, it is the responsibility of the study team to protect the participants by not being burdensome or unreasonable, and by recognising and foreseeing potential risks, especially when the participants are vulnerable (Oppenheim, 2001; Sapsford, 2007; Curtis and Drennan, 2013; Parahoo, 2014). Fever is an unpredictable symptom, and the duration of fever varies for different causes, persons and conditions (Gregson and Mackowiak, 2004; Broom, 2007). The only way to directly observe patients with fever is to recruit them while they are experiencing fever. However, patients in a febrile state can be vulnerable, uncomfortable and weak. Since it is possible to collect survey data from nurses without involving the patients themselves in direct observation, or asking patients to give consent, it seems more ethical to use nurse surveys rather than direct observations. Moreover, recruiting patients who are experiencing fever can be difficult. Due to the discomfort caused by their illness, and the focus on receiving care to alleviate their fever symptoms (Ames et al., 2013), some patients might be unwilling to participate in the study, resulting in a low number of participants. To avoid having to contact patients directly, the researchers can, instead, survey nurses to obtain quality data about fever management. The survey used to record nurses' fever management and their clinical interventions is discussed below. Other ethical issues are discussed later in this chapter.

The survey administered in this study was a retrospective questionnaire in which participants were asked to look back at general situations that had already taken place. A disadvantage of such retrospective surveys is that the data recorded has reduced accuracy and consistency because people's memories are unreliable. Moreover, the survey might not represent the reality of fever management practice (Sedgwick, 2014).

In summary, a survey of nurses is a more efficient and ethically appropriate way of collecting patients' related data than is direct observation but it might record less accurate information.

3.3.4 Using the survey in the study

Accordingly, a survey was conducted to understand the nurses' knowledge of fever and their fever management practice.

Sapsford (2007: 3) defined a survey as

"a collection of quantified data from a population for purposes of description or to identify covariance between variables which may point towards casual relationships or predictive patterns of influence."

Surveys are usually used to study large populations or groups using a standardised quantitative approach to identify beliefs, knowledge, attitudes, behaviours and other characteristics (Oppenheim, 2001; Sapsford, 2007; Curtis and Drennan, 2013). Questionnaires are commonly used, but other techniques, such as structured interviews, observations and content analysis can also be performed to conduct a survey (Fowler, 2009). Questionnaires allow researchers to collect a large amount of data in a relatively short period of time, and they help researchers to standardise the results (Oppenheim, 2001). Surveys play an important role in healthcare research because they are an advantageous research methodology for gathering systematic information on the same characteristics (Sapsford, 2007; Fowler, 2009; Keough and Tanabe, 2011; De Vaus, 2014). To conduct a survey, a standardised approach is used to ensure the data's reliability and validity. In addition, the process can ensure that the results can be generalised to the wider population when the same information is collected from different individuals (Sapsford, 2007; Keough and Tanabe, 2011; De Vaus, 2014). Compared with other research methods, surveys are economical and can be conducted easily. Information from different dimensions can additionally be collected by survey research, including demographic data, attitudes, knowledge, health history and opinions (Fowler, 2009; Keough and Tanabe, 2011; Halbesleben and Whitman, 2013).

Conversely, poorly designed surveys offer little in the way of meaningful data, such as when the measuring devices are not accurate, or the instrument used has not been validated, or when the respondents do not feel encouraged to provide accurate, honest answers (Sapsford, 2007; Yoo et al., 2012; Phillips, 2015). The validation issue is especially serious for self-administrated questionnaires. A self-administrated questionnaire consists of questions that each respondent completes by themselves (Oppenheim, 2001; Sapsford, 2007). In this case, respondents may not be fully aware of their reasons for giving any particular answer because of a lack of memory on the subject, or boredom with the questionnaire, which can result in a low response rate. Additionally, both survey questions and answer options could be misread by such respondents, which can lead to biases and missing answers (Oppenheim, 2001; Sapsford, 2007). In contrast, a person-administered survey, in which an interviewer reads the survey questions to the respondent, for example a face-to-face interview or a telephone survey, is more reliable. However, a person-administered survey can be time consuming and costly to implement, and some of the questions can still be misunderstood (Sapsford, 2007; Yoo et al., 2012; Phillips, 2015). At the same time, reported behaviour, such as self-administered survey, can still be inaccurate even when the respondents are being observed. Participants might not answer the survey truthfully because they may not feel encouraged to provide accurate, honest answers (Fowler, 2009). To minimise such problems, participants should feel unthreatened when answering questions in the survey. Additionally, participants might not give an accurate answer because they might genuinely believe they do things in a certain way when in reality they do things differently. For example, they may believe they spend 15 seconds washing their hands when in reality they only spend 5 seconds (Fowler, 2009; Curtis and Drennan, 2013).

Overall, a survey is an efficient and convenient method of data collection for large populations or to explore a broad issue. Nevertheless, respondents taking part in a survey may misunderstand questions, skip questions, incorrectly fill out survey items, or give incomplete or inaccurate answers. It is, therefore, of extreme importance to ensure the accuracy of the survey by making sure that the same item measures the same thing across similar respondents. Establishing validity and reliability in relation to the chosen method is intrinsic to quality design and implementation. Pilot studies are used to assess such reliability and validity. Apart from assessing the methods of survey, few surveys report details of this early step in survey development (Oppenheim, 2001; Sapsford, 2007; Curtis and Drennan, 2013).

3.3.5 Understanding factors related to fever management and fever knowledge

Besides knowledge, epistemology is concerned with the process of 'knowing'. For this study, epistemology concerned the question 'How do the nurses know what they know?' The study included the nature, scope and sources of the nurses' knowledge. There are several ways of knowing what we know, thus epistemology has been described as 'providing a philosophical grounding for deciding what kinds of knowledge are possible and how we can ensure that they are both adequate and legitimate' (Crotty, 1998: 8). Traditionally, researchers have used qualitative research methods to understand epistemology.

The aim of this research was to understand how nurses' use knowledge of fever in their clinical decisions on pyrexia-related nursing interventions to manage adult patients' fever. The questionnaire was designed to understand nurses' fever knowledge and management.

Although the survey could help to record the nurses' fever knowledge and management, it could not provide an in-depth understanding of the relationship between the nurses' fever knowledge and their management of fever, or the rationale for their fever management. Therefore, a qualitative research method was chosen in order to understand the factors linking nurses' fever knowledge and fever management. Some qualitative data-collection methods are believed to provide a more in-depth understanding of phenomena. There are many different types of qualitative data-collection methods, such as focus groups, interviews and observation. As mentioned above, observation would be ethically inappropriate and is difficult to implement. Both focus groups and interviews are effective data-collection methods for understanding certain topics in depth (DiCicco-Bloom and Crabtree, 2006). Interviews are most appropriate when little is already known about the study phenomena or when detailed insights are required from individual participants. One-on-one interviews are also appropriate for exploring sensitive issues that are difficult to discuss in a group setting (Parahoo, 2014). Also, in a group interview or focus group, a participant might be influenced by the other participants, or one of the participants might dominate the discussion leaving the others little or no time to make a statement (Parahoo, 2014). Consequently, the one-on-one interview was selected as the data-collection method for this study in order to obtain a deeper understanding of the nurses’ knowledge of fever and how they manage febrile patients.

3.3.6 Mixed method research

A mixed method approach was used in this study in order to explain and interpret the nurses’ fever knowledge and their management of fever, and to address these issues at different levels. This study aimed, not only at getting a general view of the nurses’ knowledge and management of fever, but also at gaining an understanding of the rationale behind their management of fever.

Social scientists in many disciplines have debated the relative merits of quantitative and qualitative methods for many decades. In fact, both of these methodological approaches have proven useful and appropriate for studying the social world. Moreover, either of these approaches can be harnessed depending on the research question and research design (De Vaus, 2014; Bryman, 2016; Hay, 2016). The quantitative study approach is more straightforward and allows the reader to grasp the outcome of the study more easily, as the results are presented as objective data. Accordingly, it is easier to repeat the study’s findings and show that the sample represents the entire population. However, the disadvantage of quantitative research is that it can only present the investigated phenomena without offering an understanding of the deeper causes that underlie those phenomena (Choy, 2014; Brannen, 2017). Whereas qualitative research is noted for providing rich and detailed data. Qualitative research is especially suitable for studies aiming to explore the relationship between two themes, as it could disclose the existence of a relationship and provide an understanding of the connection between the themes (Parahoo, 2014). Furthermore, compared to a quantitative research strategy, qualitative research is one of the research strategies that deals with each individual's experience and its context. Nevertheless, as the sample size for qualitative studies tends to be smaller, the results from qualitative research are not highly representative and cannot be extrapolated to other contexts (Choy, 2014; De Vaus, 2014; Bryman, 2016; Hay, 2016; Rahman, 2017).

Consequently, social scientists have used a mixed method research approach for some time, particularly in nursing and healthcare research which is concerned not only with the phenomena themselves, but also where a fuller and more in-depth knowledge of such phenomena is required. In addition to the multiple-strategy approaches that typify mixed method research, working with different types of data and utilising different investigators could also be considered mixed method research (Bryman, 2016). Although there is a long and well-established tradition of mixing quantitative and qualitative methods in the social sciences, the explicit and acknowledged recourse to mixed method research designs has become increasingly popular since the 2000s (Guest, 2013).

The conduct of mixed method research involves utilising more than one type of research method in a project. Consequently, it is important for the research design to determine whether the research strategies would be conducted mostly under one lead paradigm, and also whether the different research strategies would be conducted at the same time or in sequence (Johnson and Onwuegbuzie, 2004; Onwuegbuzie and Collins, 2007; Onwuegbuzie et al., 2017). Conducting both research strategies at the same time is called concurrent design, while conducting one research strategy after the other is called sequential design. The use of both qualitative and quantitative research in harness is associated with the dominant current epistemological and ontological positions (Bryman, 2016). In this study, both inductive and deductive logic are employed. These approaches are employed together to integrate the data from both the qualitative and quantitative results. The integration of different approaches in the research methodology can be successful when the paradigms are properly reconciled (Plowright, 2011).

Deductive logic is commonly used in social research, for example to test a theory or to condense a large database. In contrast, inductive reasoning is used to generate a theory from the observations; such a theory is called the outcome of the research (Loseke, 2007). Bryman (2016) suggests that deductive and inductive strategies are better thought of as tendencies rather than as elements that can be separated from each other (Bryman, 2016). Teddlie and Tashakkori (2010) argue that a mixed method research design, employing both inductive and deductive logic, can be illustrated as a chain of reasoning in its sequence (Tashakkori and Teddlie, 2010; Teddlie and Tashakkori, 2010; Teddlie and Tashakkori, 2012). Consequently, the present study used deductive logic to narrow the gap between fever knowledge and clinical practice in order to look into specific gaps in-depth.

In the present study, a quantitative research method was used to strengthen the generalisability of the study. Also, the quantitative research method was helpful in gathering a wide range of information from a large number of participants (Plowright, 2011). By also using a qualitative approach, the findings from the interviews could offer opportunities to generate theories and strengthen concepts (Johnson and Onwuegbuzie, 2004; Teddlie and Tashakkori, 2010; Plowright, 2011; Tariq and Woodman, 2013; Yardley and Bishop, 2015; Bryman, 2016; Brannen, 2017; Bressan et al., 2017). Qualitative data were also necessary to further investigate the participants’ perceptions and experiences explored in this study. The researcher found that, although there are important paradigmatic differences between qualitative and quantitative research, there are also some similarities which are often overlooked. For example, both quantitative and qualitative researchers draw on empirical observation to address and answer research questions (Guest, 2013; Tariq and Woodman, 2013; Yardley and Bishop, 2015; Bryman, 2016; Kaur, 2016; Brannen, 2017; McKim, 2017).

The research world of today is becoming increasingly interdisciplinary, complex and dynamic. Therefore, it is becoming increasingly popular to complement one method with another. Indeed, using multiple methods can help to facilitate communication, to promote collaboration and to generate better research. The mixed and matched design components sometimes offer the best chance of answering research questions (Johnson and Onwuegbuzie, 2004; Yardley and Bishop, 2015; Brannen, 2017; McKim, 2017; Onwuegbuzie et al., 2017). Taking a broad philosophical approach or pluralist position will help to improve communication among researchers from different fields as they attempt to advance knowledge together (Maxcy, 2003; Johnson and Onwuegbuzie, 2004). How research approaches can be fruitfully mixed also remains a challenge. Although many research procedures and methods are linked to certain paradigms, this link between research paradigm and method is neither sacrosanct nor essential, suggesting that qualitative researchers should feel free to adopt quantitative methods and quantitative researchers should feel free to try qualitative methods (Howe, 1992; Howe, 1988). Also, research in a domain that is dominated by one method can often be better informed by introducing the use of multiple methods. In other words, as long as the combination of methods offers the best opportunity to answer research questions and reduce biases, the mixed method approach promises to be a positive methodological trend (Maxcy, 2003; Johnson and Onwuegbuzie, 2004; Tariq and Woodman, 2013; Hay, 2016; Bressan et al., 2017).

3.4 Ethical considerations

A primary concern in conducting research is that the researchers do no harm. Before any research involving human beings is initiated, researchers should identify the risks and discomforts, as well as any anticipated benefit for the participants (Rogers and Lange, 2013). When conducting a study, risks of harm should always be examined and removed where possible. However, nursing and health care are broad fields and it is difficult to know in advance all the possible behaviours and actions that a participant might undertake in a given situation (Israel and Hay, 2006).

In the present study, no direct contact with patients was involved and no identifiable data of patients was to be gathered. Although no direct contact with vulnerable patients was required for this study, the study was defined as containing information with a medium risk of confidentially. Such ethical issues are raised for all healthcare research. In this study, access to a group of qualified participants to administer the questionnaire was essential. This meant asking for permission to recruit registered nurses in wards in different NHS regions. In order to obtain the different types of permission needed at different NHS levels this study was first reviewed by the School of Health in Social Science Ethics Committee at the University of Edinburgh (see Appendix A for the letter of approval). The study was also assessed by the NHS Research and Development in each region. This study was advised as service evaluation. The NHS Health Research Authority (2013: 4) defined the study activities as follows.

1. ‘Service evaluation’: designed and conducted solely to define or judge current care.

2. ‘Research’: the attempt to derive generalizable new knowledge including studies that aim to generate hypotheses as well as studies that aim to test them. Specific questions generate a protocol driven project to derive new knowledge and understanding.

3. ‘Clinical audit’: designed and conducted to produce information to inform delivery of the best care, which serves to identify if desired standards of service delivery are being met.

4. ‘Surveillance’: designed to manage outbreak and help the public by identifying and understanding risks associated.

5. 'Usual practice': designed to investigate outbreak or incident to help in disease control and prevention.

Among all of the categories, only 'research' would require a NHS ethical review (Chen and Fawcett, 2017). Therefore, this study only required the institutional ethics review, which was the ethical review conducted in the University of Edinburgh. During every phase of this research, the researcher reflectively reviewed whether any potential harm or risk would be inflicted upon the participants. This research was conducted independent of sponsors or funders, and no conflicts of interest arose during the course of this research.

3.4.1 Informed consent

To address ethical concerns, all participants of the survey were fully informed about the purpose and process of the research. Participants were assured of the anonymity of their participation. Gaining access, i.e. explaining the nature of the study and the role of the researcher, was, in itself, part of the study and acted as a giving of formal or verbal consent. Consent did not necessarily imply or require a specific written or signed form; it was the quality of the consent that was vital. Potential participants had the right to know the content of the study and were given the right to refuse to participate (DeWalt and DeWalt, 2002). With good clinical practice in mind, the principle that researchers should provide information about the study and that participants should fully understand the procedures of the study was designed to protect the individual's freedom of choice and respect the individual's autonomy (Noorzurani et al., 2009).

In this research, potential participants were approached through different organisations, institutions and individuals. The information about participating in the study was mostly circulated by head nurses or nurse managers. It was essential to let the potential participants know that there was no obligation to complete the survey and the survey was unconnected to the nurses' NHS employment because otherwise they might have felt pressured to complete it

(DeWalt and DeWalt, 2002; Payne and Payne, 2004; Littlewood, 2007). As with the interview, the survey could prove to be difficult when the goal of the study raised uncomfortable issues for the participants. In the present study, interviewers asked registered nurses about the reasons for their choice of certain interventions. It was possible that some of the participants felt threatened by these questions and became defensive about their management approach. In order to minimise this issue, the wording of the questions was carefully chosen, and the interviewers always emphasised that there were no right or wrong answers (Jameton, 1984; Wilkinson, 1987; Nieswiadomy and Bailey, 2008; Brinkmann, 2014). Each interview was suspended if the respondent expressed any distress, and in such cases, support from the line manager, general practitioner or counsellor was advised. However, none of the participants showed that they were offended or distressed during the study. The consent form and information sheet of the questionnaire were showed in the first page of Appendix B, while the interview consent form and interview information sheet were presented in Appendix C.

3.4.2 Anonymity and data storage

All the data from both the questionnaires and interviews were anonymised. The demographic part of the data did not include identifiable data about the participants and was coded into numbers. The published results would not contain any personal data that could allow the identification of any individual participant. Confidentiality is essential and privacy and confidentiality rules, in accordance with the applicable regulatory requirements that constitute good clinical practice, were respected (Israel and Hay, 2006). Even though no identifiable data was to be used in the study, the researchers developed a range of methodological precautions for data protection regarding the collection, analysis and storing of data. Limited access to the data was secured by keeping the data either inside a locked cupboard or on a computer that required a username and password.

The survey tool BOS, provided by the University of Bristol, was used to design and distribute the questionnaire as it offers high-level data protection. The license to use the BOS software was provided by the University of Edinburgh. The data was stored and processed in a password-protected account on a server at the University of Bristol. Some interviews were conducted using online communication tools such as Skype and Facetime, or by telephone with a recorder to record the conversation. These interviews were held in a quiet room at the University of Edinburgh and could not be overheard. All the electronic and digital records were stored on the University of Edinburgh's computer, offering a high level of security and password protection. All paper documents, such as consent forms, were stored in a locker at the University of Edinburgh. Access to the data on the computer was password protected and restricted to only three users. All raw data were coded to retain anonymity and protect the identity of participants. Only the researcher and her supervisors had the password to access the results of questionnaire and interview. All data will be retained for a period of 3 years after the completion of the researcher's PhD. After 3 years the data files will be deleted in compliance with University of Edinburgh guidelines.

3.4.3 Beneficence and establishing rapport

Another principle underpinning healthcare research is the principle of beneficence, which indicates that the study should work for the benefit of the participants or the function of the healthcare institution from the healthcare professional's perspective (Parahoo, 2014). Although this study offered no direct benefits to the participants or their healthcare institution, the implications of the study may eventually improve patient care in alleviating suffering from fever. Moreover, on completion of the questionnaire, an educational package about fever was given to the participants so they would have up-to-date information about pyrexia that could potentially enhance their ongoing professional development in the management of fever.

The need to develop a situation of ‘trust and cooperation’ between the researcher and the participants is identified in healthcare studies (DeWalt and DeWalt, 2002). One issue relevant to establishing rapport concerns the accuracy of the research data. When rapport is absent, there can be little or no trust between the informant and the researcher, and there are few guarantees of the validity and worth of the information gathered in an atmosphere where confidence has not been established (O'Reilly, 2012). The relationship between the researcher and the participants has to be built over time. There have been cases of people under study who have grown to be highly suspicious of the research, resulting in difficulties in gathering reliable data (Hammersley and Atkinson, 2007; Kelley et al., 2011). To build the relationship of trust that is required, the researcher must show respect for the participant, be a good and careful listener, and be ready to reciprocate in appropriate ways (Rogers, 2014).

3.5 Data collection

A mixed method design was adopted for this study, with an initial questionnaire used to gather information about nurses’ knowledge of fever and their fever management. The questionnaire was designed and distributed through Bristol Online Survey (BOS). Three strategies for recruiting participants were used at the same time during the questionnaire’s data-collection stage. First, the Royal College of Nursing (RCN) helped to provide access to the study population. Second, the lead NHS research nurse in each region was contacted to assist with advertising the study. Most of the lead research nurses chose to forward the questionnaire to their head nurse, while some of the lead research nurses advertised the study during their morning meeting. Lastly, snowball sampling was employed, which the questionnaire was send to potential participants and those participants helped to share the questionnaire. At the end of the questionnaire, participants were asked whether or not they would like to take part in a future study and, if interested, to provide their contact information. Those who voluntarily left their contact information were contacted and invited to be interviewed. After a brief study of the questionnaire data by the researcher, the survey respondents who had expressed a willingness to participate in the interview were interviewed by semi-structured interview to further explore the relationship between their knowledge of fever and their fever management. The interviews were conducted either face to face, by telephone, or online using communication applications such as Skype or FaceTime. The time and method of interview were arranged at the participant’s convenience.

3.5.1 Design of the questionnaire

The combining of questionnaires is one of the most widely used research methods in the social sciences and psychology studies (Oppenheim, 2001; Robison, 2018; Verma, & Abdel-Salam, 2019). Despite widespread use, a few principles about those tested questionnaires can often be neglected, for example, the research design of the original questionnaire. Using the questionnaires for different purposes or misunderstanding the aim of the questionnaire may have major implications for research and practice. Moreover, unreliable scales can distort research findings, hinder theoretical development, and result in ineffective or even counterproductive practice. A solution to this is to recheck the validity and test the consistency of variables (Oppenheim, 2001; Robison, 2018; Verma, & Abdel-Salam, 2019). Using the questions which have already been developed has several advantages. First, the questions would have already been tested at the time of their first use. Therefore, this saves in terms of both money and time. A third advantage is that in some substantive areas, methodological work on conceptualisation and measurement has been done; this can complement the questions and provide guidance as to how they can act as indicators of concepts (Hyman, Lamb & Bulmer, 2006).

The questionnaire in this study included two sections. The first section examined participants’ fever knowledge while the second section investigated the participants’ fever management. The questionnaire is presented in Appendix B.

3.5.1.1 Section one: Knowledge about fever

The fever knowledge section was based on two pre-validated questionnaires. It consisted of seventeen questions about fever knowledge, followed by two questions about participants' thoughts about fever.

Kiekkas et al. (2014) study nurses working with adult patients used a questionnaire divided into two parts: an attitude section and a knowledge section. From the study by Kiekkas et al. (2014), the researcher only adopted the knowledge section, as attitudes towards fever was not considered relevant to the study's questions. There were ten items in the knowledge section for which Cronbach's alpha was 0.8. Of the ten items in the knowledge section, five were about fever and the other five were about antipyretics. The questionnaire was originally in Greek and then translated into English by an expert in nursing research who is bilingual in Greek and English (see Appendix D). On this basis, the content validity of the questionnaire was reviewed by experts. Another seven questions in the knowledge section of this study came from a pre-validated questionnaire designed by Walsh et al. (2005), which included twenty knowledge questions (see Appendix E). The questionnaire was originally designed for paediatric nurses. The questionnaire was also used in other studies (Edwards et al., 2007; Greensmith, 2013). The reliability test by Walsh et al. (2005) yielded a Kappa of 0.644. Greensmith (2013) also checked for test-retest reliability, which was consistent in the retest result. The questionnaire was validated for content validity by expert panels (Walsh et al., 2005; Edwards et al., 2007; Greensmith, 2013). Within the twenty questions, questions related to paediatric care, duplicated questions or questions which disagreed with latest scientific evidence from Walsh et al. (2005) were excluded. Finally, six questions were added into this survey, which were questions 3,4,5,10,16,20 see Appendix E. In addition to the knowledge questions, a question associated with the definition of fever and two questions related to thoughts about fever were included in this questionnaire.

Ultimately, there were seventeen questions in the first section of the questionnaire. Ten of the questions were from Kiekkas et al. (2014), which was translated to English and six questions were from Walsh et al. (2005). A pilot study was conducted with five participants to ensure the validity and reliability of the questionnaire. The Cronbach's alpha was 0.745 in the knowledge section.

3.5.1.2 Section two: Management of fever

A pre-validated questionnaire related to fever management was found in a neuroscience study (Thompson et al., 2007). The questionnaire, which had been used in two large studies, was validated using face and construct validity (Thompson et al., 2007; Rockett et al., 2015). An adapted version of the original survey from Thompson et al., (2007) was used in this fever study since some of the original questions related to neuroscience were excluded mostly from the demographic section of the questionnaire.

The full version of the questionnaire used in this fever study is given in Appendix B. Information about the study and consent is given on the first page of the questionnaire. Demographic questions about the registered nurses, such as gender, age, working area, clinical experience and education, are designed into the questionnaire in order to identify the relationship between those variables and the nurses' knowledge of fever. The items in the questionnaires concerned the definition of fever, the thermoregulatory centre of the human body, fever aetiology, the effect of fever on heart rate, the site for the most accurate temperature measurement, when is fever treatment justified, how antipyretics suppress fever, side effects of pharmaceutical and physical antipyretics, the recommended daily dose of paracetamol for treating fever, participants' thoughts about fever, and the management used when encountering fever patients. At the end of the questionnaire, each participant was asked whether or not they would like to be involved in a future study; if they answered yes they were asked to leave their contact information. A pilot study was conducted with five participants to ensure the validity of the questionnaire.

3.5.2 Interviews

Qualitative interviews allow opportunities for mutual discovery, understanding, reflection and explanation in a direct way. Interviews elucidate respondents’ subjective viewpoints and perspectives (Tracy, 2012). There are many ways to conduct an interview, for example unstructured interviews, semi-structured interviews or structured interviews. During an unstructured interview the interviewer guides naturally occurring conversations, while structured interviews are usually surveys which include a fixed set of closed questions. A benefit of a structured interview is that it might be possible to analyse the data quantitatively. However, the structured interview lacks the flexibility and nuances of a natural conversation. In contrast, a semi-structured interview is structured around a set of themes which serve as a guide to facilitate the interview. Unlike the structured interview, the interviewer is expected to adapt, modify and add to the prepared questions if the flow of the conversation suggests it. The advantage of the semi-structured interview is that it provides for the direction as well as flexibility of a conversation. Nevertheless, one of the disadvantages this approach is that it might be difficult for a novice interviewer to let the conversation flow naturally. Accordingly, the semi-structured interview can be challenging for an interviewer as it requires the ability to improvise during the interview. The unstructured interviews are where the interviewer guides topical though natural conversations, which are initiated with a starting topic. A positive aspect of the unstructured interview is that it allows the interviewers to guide the conversation in a natural way, letting it move flexibly according to what emerges. Therefore, the unstructured interview could yield unanticipated rich data. The unstructured interview is most frequently used in ethnographic interviews. A shortcoming of the unstructured interview, despite the provision of immediate fluid responses, is that such interviews sometimes flow off topic and depart from the research aim

(Oppenheim, 2001; Wengraf, 2001; DiCicco‐Bloom and Crabtree, 2006; Cousin, 2009; Tracy, 2012; Dubickis and Gaile-Sarkane, 2017).

In this study, a semi-structured interview approach was adopted in order to ascertain the participants' perceptions of fever and their response to fever in an open-ended manner (Abraham and Sheeran, 2005). Besides, the semi-structured interview is a powerful tool for capturing the meanings that people assign to their lived experience (Rabionet, 2011). The semi-structured interview can also help to keep the conversation focused on the research themes while at the same time allowing the conversation to develop thoroughly. Additionally, asking the respondents open-ended questions prompts them to answer at length on their own terms. This can be beneficial to the study by opening the exploration to areas where the researcher has limited knowledge or where they have not yet grasped the importance of certain knowledge (Oppenheim, 2001; Wengraf, 2001; DiCicco‐Bloom and Crabtree, 2006; Cousin, 2009; Tracy, 2012; Choy, 2014; Bryman, 2016; Dubickis and Gaile-Sarkane, 2017).

The purpose of using interviews in the present study was to explore the relationship between fever knowledge and fever management. Consequently, the questions in the semi-structured interview were designed after a brief analysis of the survey, which revealed the areas that required further inquiry. Preferably, such interviews are conducted face-to-face. An advantage of a face-to-face interview is the rapport that develops between the participant and interviewer, encouraging the participant to say more. This approach also avoids the technical biases that technology often introduces (Oppenheim, 2001; Wengraf, 2001; DiCicco‐Bloom and Crabtree, 2006; Cousin, 2009; Tracy, 2012; Choy, 2014; Bryman, 2016; Dubickis and Gaile-Sarkane, 2017). However, since some of the participants were based at distant locations, it was not always possible to conduct a face-to face-interview. As a result, telephone, Skype or Facetime interviews were also used.

The potential participants in the interview phase of the study were contacted if they had confirmed their willingness to be interviewed and had left their contact details on the questionnaire. Before the interview began, the participants were fully informed about the study and only after they had given their consent were the recorders turned on to record the conversation.

An initial analysis of the survey showed uncertainty both in relation to fever pathology and its management. Moreover, it was unclear whether actual knowledge of fever influenced how the participant actually managed fever. This prompted further questions:

- What are your thoughts about fever and fever control?
- Can you tell me about your recent experiences of fever in your patients? / What would you do if you have a patient with a fever?
- What is it that makes you feel you need to intervene and manage fever?
- What do you think influences your decision making to intervene? (Where do you think this comes from?)
- How would you evaluate your knowledge and skills in relation to fever?

A pilot study with two participants was conducted before the interviews to assure the content validity for the actual interview research. The pilot interviews showed that the questions were appropriately designed. The limitation of this pilot study was that it involved a small number of participants which as expected would not achieve data saturation. Despite the small-scale, this pilot test demonstrated the interviews usability and practicality in exploring the above questions.

3.5.3 Recruitment

The inclusion criterion for the survey was being a registered nurse in Scotland. Potential participants who had not given their consent were excluded (see

Appendix B). The survey was distributed though the RCN, NHS boards and by snowball sampling. After the ethical review and approval, the RCN was contacted. The RCN helped to send out the link of questionnaire to some of their members. Distribution through the NHS, was by contacting the individual health boards. Each board reviewed the study and categorised this study as service evaluation. After the review, each NHS board distributed the link to the questionnaire in different ways. Some of the questionnaires were sent through emails, while some of the questionnaires were distributed in the morning meetings. Finally, a few nursing colleagues who were working in Scotland helped to send out the link of questionnaire to their friends and colleagues. Potential interview participants were recruited if they had completed the survey and indicated their willingness to participate in the interview. Again, a signed consent form or verbal consent was needed before the interview. The verbal consent was only used if the participant had difficulty signing a consent form prior to the interview.

In order to keep in touch with the participant and interview the participants, while the memory for the questionnaire was still fresh, the interviews were scheduled within 2 months after the completion of questionnaires. With the limited time, therefore, only initial analysis of the survey data could be done before the semi-structured interviews. A more detailed analysis of the questionnaire was carried out after the interviews.

3.6 Data analysis

3.6.1 Statistics

The quantitative data from the questionnaire about fever knowledge was analysed using the Statistical Package for Social Sciences, version 21.0 (SPSS Inc., Chicago, IL, USA). In the results from the questionnaire, a correct answer on the knowledge-evaluating items was scored as 1; an incorrect answer was scored as -1 and a 'not sure' answer was scored as 0. The scores were summed to calculate the total fever-knowledge score. This could help to understand individual participant’s overall knowledge in fever. Simple descriptive statistics was used to calculate the average knowledge score for each participant and each aspect of their knowledge was examined. Demographic data, such as gender, was coded using a nominal scale. The nurses’ ages and academic qualifications were coded as ordinal data, while the nurses’ years of experience were placed on a scale. The Mann-Whitney U test was used to test the non-parametric items; for example, the difference in the total knowledge scores of the participants who had a higher level of education degree in nursing. The distribution of rank in the respective total knowledge scores of the two groups, such as participant who had a Bachelor degree in nursing and participants who did not have a bachelor degree in nursing was compared. The results of Mann-Whitney U test were displayed showing the z-value, mean rank and p-value. Spearman’s rho correlation coefficient and the Pearson correlation coefficient were employed to calculate the linear correlation. While the Spearman’s rho correlation coefficient was used for nonparametric correlation, the Pearson correlation coefficient was used for parametric linear correlation, such as the correlation between knowledge score and the length of clinical experience. The relationship between fever knowledge and the other demographic variables of the participants, such as their location of work and working units, was also tested using a chi-square test. The phi coefficient is shown alongside the chi-square, as phi-coefficient can adjust the chi-square when the sample size of subgroups in the data set was not even. The likelihood ratio is also displayed for many chi-square tests, as the likelihood ratio is more meaningful than chi-square when the data set is small (Sapsford, 2006; Yoo and Harman, 2012; Curtis and Drennan, 2013; De Vaus, 2014). All the significant correlations in the next chapter are presented by p-value. A p-value less than 0.05 is considered significant. As for the strength of the correlation, r is taken as the reference. An r between ±0 and 0.3 is considered a weak correlation, while the range of ±0.3 to 0.6 is considered a moderate correlation. Finally, an r larger than 0.6 is considered a strong correlation. The definition of the strength of correlation is slightly different in several statistical reports (Bobko, 2001; Chen and

Popovich, 2002; Quirk and Cummings, 2017; Burdess, 2010; Ben-Zvi et al., 2018).

3.6.2 Thematic analysis

The semi-structured interviews were recorded using a digital recorder and the interviews were transcribed for analysis. Approaches to qualitative data analysis are numerous, representing a diverse range of epistemological, theoretical and disciplinary perspectives. Qualitative data analysis consists of a set of interpretive, material practices that illuminate data sets. The qualitative analysis can transform and translate the observations, including field notes, interviews, conversations, photographs, recordings and memos to self. This reflects the fact that qualitative researchers study things in their natural settings, and attempt to make sense of, or to interpret, phenomena in terms of the questions people bring to them (Wengraf, 2001; Johnson and Onwuegbuzie, 2004; DiCicco‐Bloom and Crabtree, 2006; Gibbs, 2007a; Tracy, 2012; Brannen, 2017). At this level, qualitative research involves an interpretive, naturalistic approach to the world. Yet, it is difficult to choose the most appropriate way to analyse such data. Different strategies, or methods of qualitative analysis, are available, such as interpretative phenomenology, grounded theory and thematic analysis, these are commonly used analytic approaches for making sense of qualitative data (Wengraf, 2001; Johnson and Onwuegbuzie, 2004; DiCicco‐Bloom and Crabtree, 2006; Gibbs, 2007a; Tracy, 2012; Brannen, 2017). Thematic analysis is described as an interpretive process by which data are reviewed in order to develop patterns to describe a phenomenon. Although thematic analysis is a way of categorising data into themes through repeatedly reviewing the data and making notes on the transcript, it is designed to disclose hidden meanings in the data (Gibbs, 2007b; Guest, 2012). Another popular methodology of qualitative research is grounded theory, which opens the way for the construction of a theory (Charmaz and Belgrave, 2007). However, the aim of the present study was to answer the research questions and find the relationship between fever knowledge and its management rather than to develop a theoretical framework. Moreover, the grounded theory approach includes guidelines for the construction of theories that would be grounded in the collected qualitative data, which is not a suitable application of the data in this study (Charmaz and Belgrave, 2007; Gibbs, 2007a; Uwe, 2014).

Consequently, this study employed thematic analysis for the data from the interviews. Thematic analysis is one of the most common forms of analysis used in qualitative research. It pinpoints, examines and records patterns, also known as themes, within the collected data. Thematic analysis was first developed by Gerald Holton in the 1970s (Braun and Clarke, 2013). Initially it was used by researchers using different strategies as part of their qualitative methodologies. However, it has recently been identified as an independent descriptive qualitative approach. Guidelines for thematic analysis, including framework analysis, were developed in the 1980s at the National Centre of Social Research in the UK (Vaismoradi et al., 2013; Ritchie et al., 2013). In 2006, Braun and Clarke published their approach to thematic analysis (Braun and Clarke, 2013). This approach can be used without the need to generate theory and applied across a range of theoretical and epistemological approaches (Smith and Firth, 2011; Braun and Clarke, 2013). Thematic analysis has been found to offer a more flexible, direct and straightforward approach for the analysis of qualitative data (Smith and Firth, 2011; Guest, 2012; Braun and Clarke, 2013; Ritchie et al., 2013; Vaismoradi et al., 2013).

Thematic analyses move beyond counting explicit words or phrases and focus on identifying and describing implicit and explicit ideas expressed within the data, these ideas are known as themes. Themes are patterns across data sets that are important to the proper description of a phenomenon and are associated with a specific research question. The thematic framework approach in qualitative data analysis involves the following five steps of data management and analysis: familiarisation, indexing and coding, searching for themes, reviewing the themes and constructing an initial thematic framework. In the familiarisation phase, researcher thoroughly and extensively engages with the data, both the transcript and the field notes. After familiarising with the data, codes are generalised. Codes are then developed to represent the identified themes and applied or linked to the raw data as summary markers for later analysis (as presented in Appendix F). Such analyses may or may not include the following: comparing code frequencies, identifying code co-occurrence and graphically displaying relationships between codes within the data set (Gibbs, 2007a; Gibbs, 2007b; Guest, 2012; Ritchie et al., 2013; Vaismoradi et al., 2013; Uwe, 2014). Following that, extracts from the data are reviewed and themes among generated code are searched. The generated themes were then 'vetted' by the researcher's supervisors in the study. Relationships between themes were then structured. Therefore, how the content of transcript and field notes are coded becomes an important issue. Data reliability can be of great concern as well, for different codes may generate different themes (as presented in Appendix G). To maintain rigour, strategies for reducing coding bias and improving intercoder agreement, and thus reliability, should be implemented in the analytic process (Gibbs, 2007a; Gibbs, 2007b; Smith and Firth, 2011; Guest, 2012; Ritchie et al., 2013; Vaismoradi et al., 2013; Uwe, 2014). It is crucial to have more than one researcher to independently analyse the data, to ensure the themes generated are unbiased and coherent (Gibbs, 2007a; Gibbs, 2007b; Smith and Firth, 2011; Tracy, 2012; Braun and Clarke, 2013; Ritchie et al., 2013). The themes in this study, hence, were analysed and compared by the researcher and her supervisors. Additionally, the codes and the themes were checked by each participant to confirm whether the codes or the themes correctly represented their views.

Such thematic analysis was not only used on interview data; it was also applied to generate themes in both the quantitative and qualitative findings. Such analyses provide a systematic and rigorous, as well as clear and transparent approach. From the deductive quantitative method to the in-depth interview, the flexibility of thematic analysis can knit both quantitative and qualitative studies together and generate new themes. It enables the development of both themes or subthemes drawn from the model as well as emergent concepts. Eventually, thematic analysis can effectively bridge the quantitative and qualitative results and weave them together (Tashakkori and Teddlie, 2010; Tariq and Woodman, 2013; Yardley and Bishop, 2015; Kaur, 2016; Brannen, 2017; McKim, 2017).

NVivo 12 software was used for data analysis in this study (Gibbs, 2007b; Parahoo, 2014). The NVivo package allowed a structured approach to coding, the development of subthemes and the modification of the themes. The backward and forward process of refinement of the themes helped to ensure the development of the themes and the implications of qualitative result (AlYahmady and Alabri, 2013; Bazeley and Jackson, 2013). After reading the transcript, coding of each line and interviews would be performed through Nvivo. Following the completion of the codes, the researcher would categorise the codes. Nvivo would be used to help the generalisation process. Finally, themes would emerge. By using the NVivo, lines in the transcript and codes could be revised more easily (as in Appendix H).

3.7 Limitations of the study

All research has limitations that are determined by its special context and this research was no exception. There were two areas of limitation, these were in the data collection phase and during the analysis.

3.7.1 Limitations in data collection

The data-collection method for the survey provided flexible strategies to approach the potential participants. However, the approaches taken varied as some of the head nurses delivered the information through email, while others provided the information about the survey during a meeting. The convenience sampling helped to distribute the survey, yet it made calculating the response rate difficult as it was uncertain who had received the information about the study. Another limitation was that the interview was limited to participants who had already completed the survey. This excluded some participants who had not yet completed the survey. The interview was estimated to be more than 30 minutes and might require travelling, which was time-consuming and inconvenient for the potential participants. The above reasons made it more difficult to recruit a larger number of participants for the interviews. However, the interview data had reached a sufficient degree of saturation as the themes from participants were repeated.

3.7.2 Limitation in the data analysis

One of the limitations of the data analysis was that the researcher’s mother tongue was not English, making it difficult for her to understand the broad Scottish accent of some of the interviewees. It was, however, possible to clear up any misunderstandings during the interviews. Although there were recorders, some of the scenarios and atmosphere could not be recorded by the recorder. For example, the facial expression might change the meaning of a sentence. However, it was difficult to remember everything said or seen in the interview. This made the transcription difficult in some instances. To reduce the confusion during transcribing, a summary of the content or the conclusion of each interview was sent to the respective participant by email for member checking. The participant confirmed if the content was accurate or not (Creswell and Miller, 2000; Cho and Trent, 2006; Houghton et al., 2013). It is noteworthy that this member checking also served to improve the validity of the qualitative data.

In order to minimise the paradigm issues, the findings of the quantitative and qualitative components were mixed in the result phase. This research strived to assure the validity and reliability of the quantitative research and the rigour of the qualitative research. Mixed method research generally takes more time to conduct than single method designs. The analysis of mixed method research can be complicated because the quantitative and qualitative perspectives are very different (Johnson and Onwuegbuzie, 2004; Teddlie and Tashakkori, 2010; Tariq and Woodman, 2013; Yardley and Bishop, 2015; Kaur, 2016; Brannen, 2017; Bressan et al., 2017; Onwuegbuzie et al., 2017). Thus, such analyses can be challenging due to the limited time available to complete the study. However, use of the mixed method research design added greater value to the results of this research.

3.8 Summary of this chapter

The main purpose of this research was to understand nurses' knowledge about fever, and to understand how nurses manage fever.

Consequently, there was a focus on the ontology as well as the epistemology of fever. This study adopted post-positivism and rationalism as its research paradigm. Positivism focuses on evidence-based data, whereas post-positivism recognises that all observation is fallible and has errors. Moreover, it accepts that all theory is revisable. Rationalism promotes the belief that all knowledge is based on logic. As a result, post-positivism was used to underpin the understanding of fever knowledge and fever management, while rationalism was used to grasp the differences between fever knowledge and fever management, also why there were differences between fever knowledge and fever management.

A mixed method approach was adopted with an initial online questionnaire designed to gather information about nurses' knowledge of fever and fever management. This was followed by semi-structured interviews with selected respondents to better understand the relationship between their knowledge of fever and fever management. The respondents were recruited if they were willing to participant in the interview. The questionnaire contained two sections, the knowledge section and the management section. The knowledge section was comprised of two pre-validated questionnaires by Walsh et al. (2005) and Kiekkas et al. (2014), while the management part used the questionnaire designed by Thompson et al. (2007). Content validity was checked by experts in the field of health care. Furthermore, a pilot study was conducted both before distributing the questionnaire and conducting the interviews. The initial analysis of quantitative data was performed to acknowledge the gap between fever knowledge and fever management. The interview questions were prepared once the results of the questionnaire data were known.

All registered nurses working in Scotland were eligible to participate in the study. Convenience sampling was applied and participants were recruited by distributing the online questionnaire in three ways; through the RCN, by the NHS lead research nurses, and by snowball sampling. At the end of the questionnaire, each participant was asked if they were willing to be involved in the future study and if so asked to leave their contact information. Those who left their contact information were invited to participate in an interview.

On completion of the data collection, the questionnaires were analysed using descriptive statistics as well as the correlation coefficient, which was used to measure the relationships between different items. Thematic analysis was employed to analyse the interviews and to link the quantitative and qualitative data. The two software programmes that were used were the BOS for designing the online questionnaire and gathering the data, and NVivo to help code the data and generate the themes.

The ethical issues surrounding the study were of great concern. This study was defined as a service evaluation by the Research and Development in each region of NHS Scotland. A service evaluation only requires an institutional ethics review, and this study was reviewed by the School of Health in Social Science Ethics Committee at the University of Edinburgh. Before commencing the study, each participant was informed about the study and asked for their consent to take part, they were also told that they had the right to withdraw from the study at any time. The data were anonymised to ensure privacy and stored inside a locked cupboard or on password-protected computer. Although no there was no foreseeable risk in the study, any potential harm or risks that could be inflicted upon the participants were reflectively reviewed by the researcher. The study was designed to use the most appropriate methods to obtain valid answers to the research questions. While these methods offered many advantages, some limitations were also noted. Calculating the uncertain response rate and issues in transcribing the interviews were identified as the main limitations of the study. The results are presented in the next chapter.

CHAPTER FOUR: RESULTS

4.1 Introduction

The salient findings of this research, from the analyses of the questionnaires and interview transcripts, are presented in Chapters 4, with a particular focus on the analysis of data relating nurses' knowledge of fever to their fever management. The present chapter focuses initially on the descriptive results concerning nurses' fever knowledge, including the knowledge-building process; it then goes on to address the findings regarding their fever management, such as different intervention approaches and the relationship of different fever managements with knowledge about fever.

The analytical approach used for data processing is explained in Section 4.2. The demographic data is analysed in Section 4.3.1, for both the questionnaire respondents and the interviewees. Descriptive results for the questionnaire and interviews are presented in Section 4.3.2, 4.3.3 and 4.3.4: Factors and influences that could impact nurses

4.2 Analytical methods

A total of 177 participants completed the questionnaire from January 2017 to August 2017. Data quality was assessed by calculating the Percentage of missing data and identifying any discernible patterns (DeSimone et al., 2015; Meade and Craig, 2012). No missing data were found among the questionnaire responses. The knowledge part of the questionnaire was designed with correct answers forming a random pattern. Discernible patterns were checked visually and by calculating the maximum number of consecutive items on a single page to which the respondent answered with the same response option. The screening showed no identifiable patterns among the answers and no appearance of strange outliers (錯誤! 找不到參照來源。). Power analysis was conducted to ensure the number of the data.

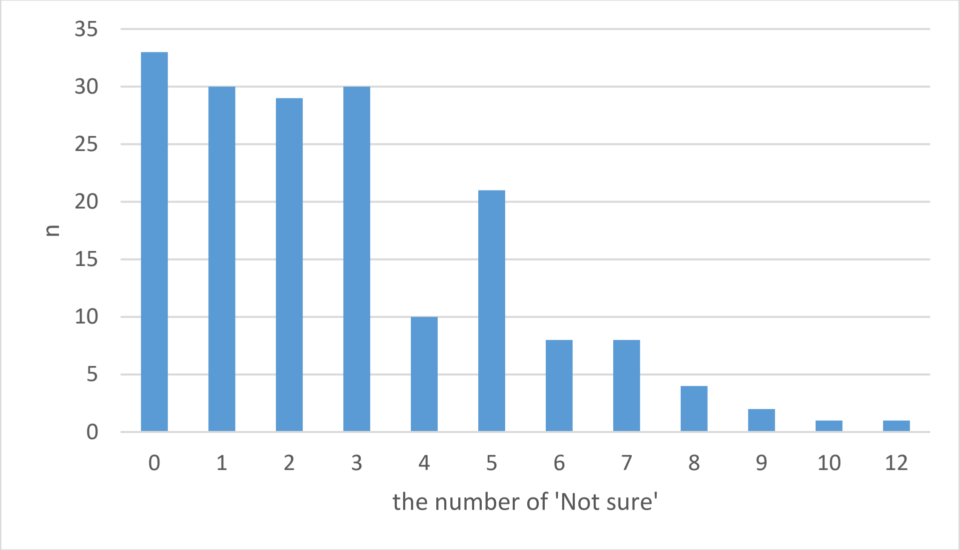

Figure 4.1 The distribution of the option ‘not sure’.

As detailed in Chapter 3, descriptive analysis was the main approach used on the questionnaire results. However, some tests of association were also used such as the chi-square test for nominal data and inter-item correlation matrices with Mann-Whitney U test for ordinal data. Probability values of less than 0.05 were accepted as indicative of significant associations, phi or the correlation coefficient respectively indicated the degree of association (Gravetter and Wallnau, 2016; Salkind, 2016; Daniel and Cross, 2018)

Transcripts of the interviews were coded and the codes arranged into broad categories and themed. This complex approach enabled the researcher to explore in depth the richness of the data. As each theme was identified, it was defined and displayed with related findings from the questionnaire. This weaving together of the qualitative and quantitative findings allowed similarities and contrasts in the data to be shown where appropriate.

4.3 Results

4.3.1 Demographic data

4.3.1.1 Questionnaire

The questionnaire was structured so that questions 1 to 10 explored demographic information, questions 11 to 27 were about fever knowledge, questions 28 and 29 explored thoughts about fever and questions 30 to 41 were about fever management.

The participants consisted of 156 (88.1%) women and 21 (11.9%) men (Table 4.), with more participants, 61, in their 40s than in any other age decade (Figure 4.). The spread of ages broadly matched the age distribution of the Nursing & Midwifery Council registration statistics for 2016/2017(Nursing & Midwifery Council, 2018) (Figure 4.).

Gender	n	Percentage
Female	156	88.1%
Male	21	11.9%

Table 4.1 Gender of the participants.

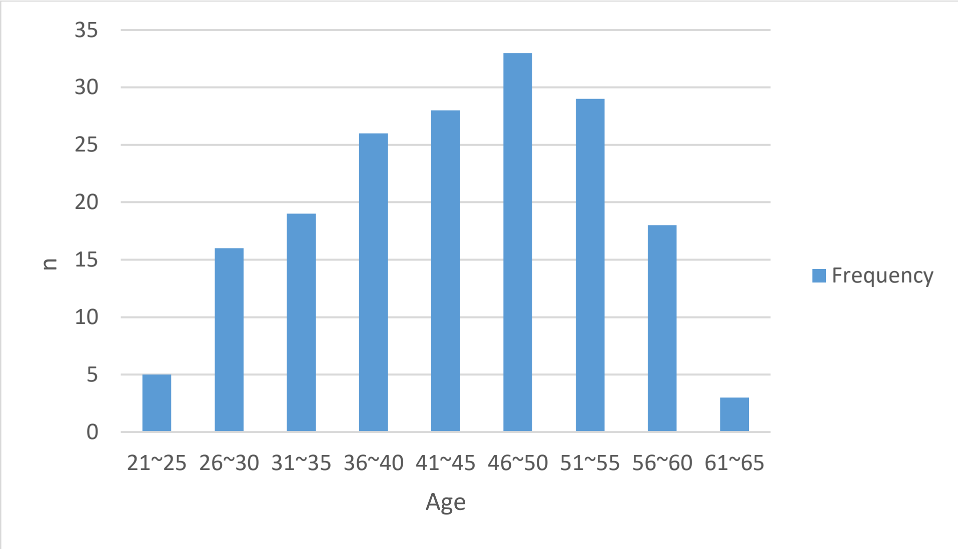

Figure 4.2 Age of the participants.

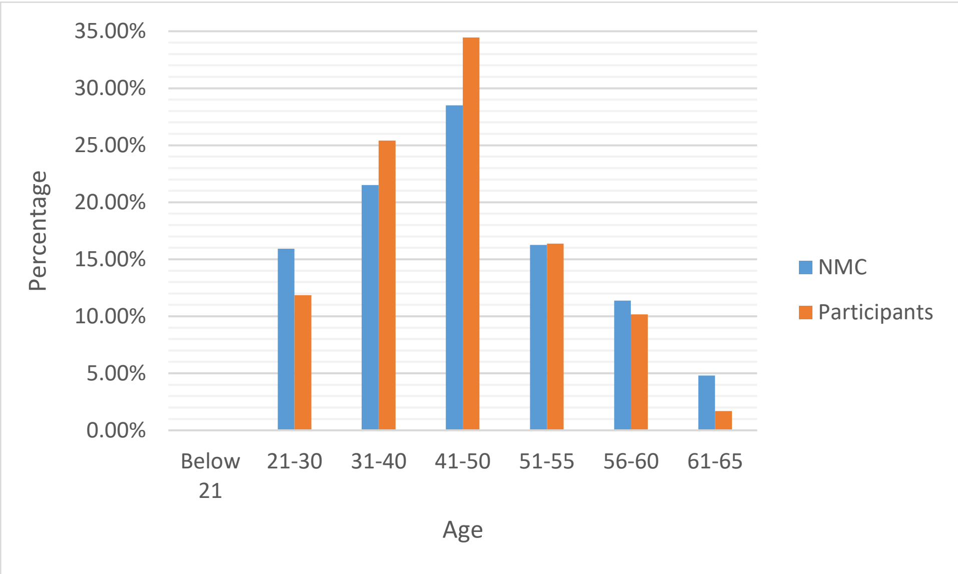

Figure 4.3 Comparison of the age group of participants between this study and Nursing & Midwifery Council data (Nursing & Midwifery Council, 2018).

The years' experience of the 177 study participants is shown in Figure 4., and ranged from newly qualified to 40 years. Each age band was well represented with numbers ranging from 11 to 32. Overall the participants' years of work experience showed a fairly even spread. The majority of participants in the study were from NHS Lothian (36.2%) and from NHS Greater Glasgow & Clyde (33.3%); while others were from NHS Fife (8.5%), NHS Highland (7.3%), NHS Dumfries & Galloway (6.8%) and NHS Lanarkshire (6.2%); and a few from the other NHS health boards. Figure 4. shows the number of participants in each NHS board.

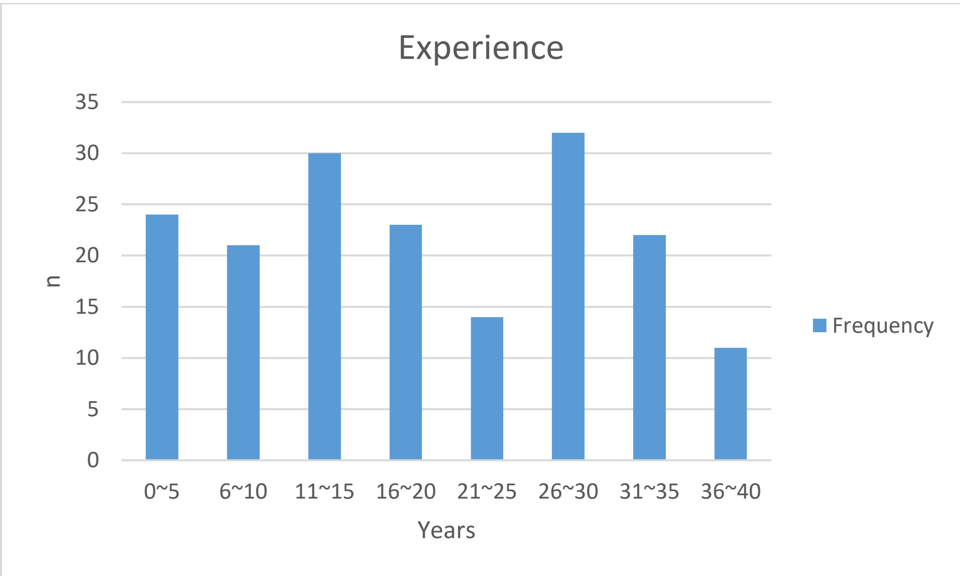

Figure 4.4 Participants' years of working as a nurse

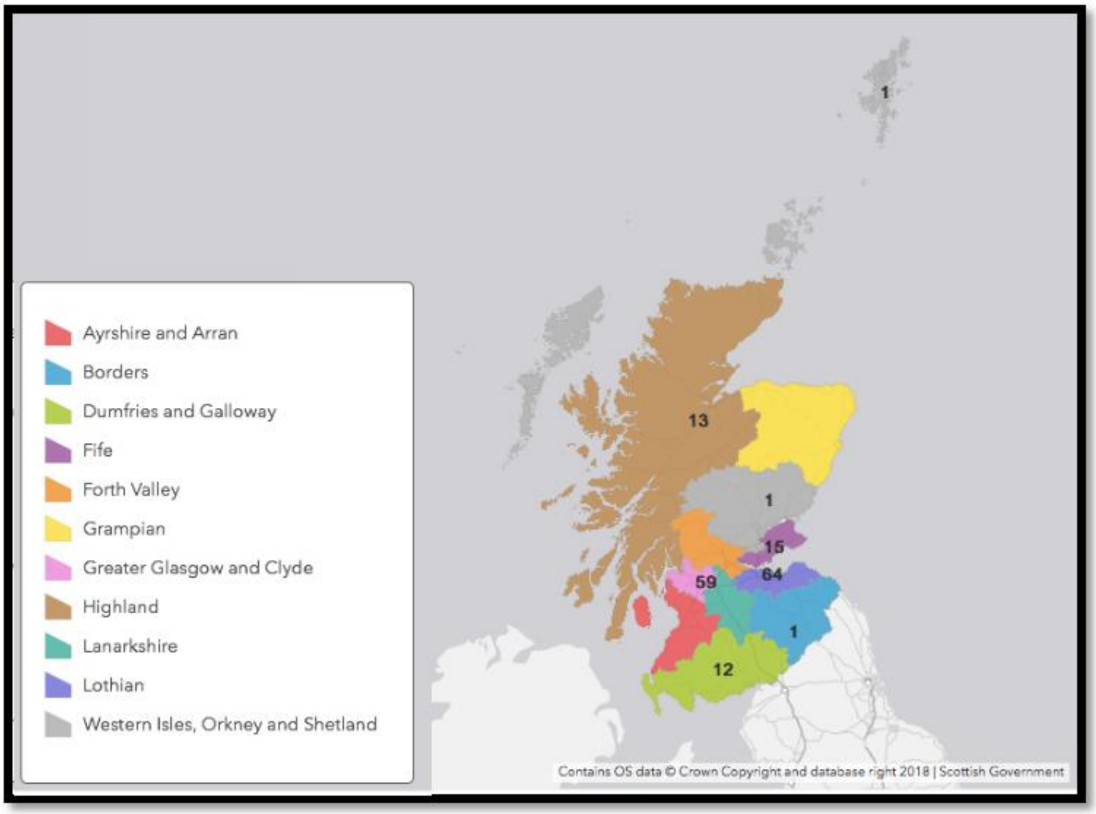

Figure 4.5 Number of participants in each health board

More than 60% of participants primarily practice in hospital, and more than 20% of participants primarily practice in community health settings (see Table 4.). The participants played different nursing roles in the clinical settings. In the questionnaire, participants were asked to indicate all of their current roles in nursing. The results showed that 37.9% of the participants reported that their only role was as a registered nurse, 16.9% of participants reported working as a research nurse, 13.6% working as a charge nurse and 13.0% working as a nurse specialist (Table 4.).

Setting	n	Percentage(%)
Hospital	111	63
Community health	39	22
Medical centre	11	6
Research facility	6	3
Clinic	5	3
Higher education institution	2	1
Other	2	1
School	1	1

Table 4.2 Participants' primary clinical practice setting.

Role	n	Percentage(%)
RN only	67	37.9
Research related	30	16.9
Charge nurse	24	13.6
Nurse specialist	23	13.0
Nurse practitioner	16	9.0
Other	12	6.8
Manager	7	3.9

Table 4.3 Participants' current roles. RN = registered nurse.

When it came to current working units, 56 (31.6%) participants were not working in a hospital setting, 47 (26.6%) participants were working in an acute care unit, 28 (15.8%) participants were working in 'other' units not listed in the questionnaire, 21 (11.9%) participants were working in a research facility, 17 (9.6%) participants were working in a surgical unit, 15 (8.5%) participants were working in a medical unit, 13 (7.3%) participants were working in a critical care unit, 10 (5.6%) participants were working in a paediatric unit, 6 (3.4%) participants were working in a rehabilitation unit, 5 (2.8%) participants were working in a neuroscience unit, and 2 (1.1%) participants were working in a psychiatric unit (Table 4.). The result showed that many participants worked in more than one unit.

As to past experience, the majority of participants, 100, had worked in an acute-care unit, 78 participants had worked in a medical unit, 73 participants had worked in a surgical unit, 71 participants had worked in a non-hospital setting, 53 participants had worked in a critical care unit, and 45 participants had chosen 'other', because they had experience working in a unit that was not listed in the questionnaire. A few participants had worked in a rehabilitation unit, a paediatric unit, a research facility, a neuroscience unit, the theatre, or in a psychiatric unit (see Table 4).

Current Unit	n	Percentage (%)
Not in a hospital setting	56	31.6
Acute care	47	26.6
Other	28	15.8
Research Facility	21	11.9
Surgical	17	9.6
Medical	15	8.5
Critical care	13	7.3
Paediatric	10	5.7
Rehabilitation	6	3.4
Neuroscience	5	2.9
Psychiatric	2	1.1

Table 4.4 Current working units of participants.

Type of past unit	n	Percentage (%)
Acute care	100	56.5
Medical	78	44.1
Surgical	73	41.2
Non-hospital setting	71	40.1
Critical care	53	29.9
Other	45	25.4
Rehabilitation	29	16.4
Paediatric	27	15.3
Research facility	21	11.9
Neuroscience	20	11.3
Theatre	13	7.3
Psychiatric	6	3.4

Table 4.5 Past experience of participants.

The questions regarding education were designed as multiple choice questions. The educational qualifications that the participants had achieved were analysed and the results are shown in Table 4.. Many participants held more than one degree. The majority of the participants, 40.1%, held a BSc or BN degree in nursing (not including BSc Hon/BN Hon), while 22.6% also held a post-graduate diploma. The result showed that the top two degrees which most of the participants held were BSc or BN degree in nursing and a post-graduate diploma. The education questions were analysed to evaluate the highest level of qualification that each participant had achieved. The results in Table 4. show that the highest level of qualification of 50 participants was a

BSc or BN degree in nursing, for 39 participants it was a post-graduate diploma, for 28 it was a Master's degree and 1 participant had completed a PhD; while the highest level of qualification for 43 participants was the state registration programme or registered general nurse diploma.

Educational qualifications	n	Percentage(%)
State Registration Programme	37	20.9
Registered General Nurse Diploma	33	18.6
Nursing Degree BSc/BN	71	40.1
Nursing Degree BSc Hon/BN Hon	30	17.0
Post-Graduate Qualification, Diploma	40	22.6
Post-Graduate Qualification, Masters	28	15.8
Post-Graduate Qualification, PhD	1	0.6

Table 4.6 Levels of education that participants had achieved.

Highest Educational Qualification Achieved by each Participant	n	Percentage (%)
State Registration Programme	23	13.0
Registered General Nurse Diploma	20	11.3
Nursing Degree BSc/BN	50	28.3
Nursing Degree BSc Hon/BN Hon	16	9.0
Post-Graduate Qualification, Diploma	39	22.0
Post-Graduate Qualification, Masters	28	15.8
Post-Graduate Qualification, PhD	1	0.6

Table 4.7 Highest level of educational qualification.

4.3.1.2 Interviews

By completing the relevant section on questionnaire, five nurses volunteered to participate in the interview phase of the study. Although only five participants were recruited in the interview, the data had reached sufficient saturation as the themes from participants were repeated. Of these, four interviewees were based in the Lothian Region while one was from Highland Region. Each of the participants came from a different professional background, and their work experience included time spent in mental health, critical care, acute care, medical, oncology and community units, and in research (Table 4.).

Among the interviewees, four (80%) were female and one (20%) was male. The age of two of the interviewees was in the range 26 to 30 years old, one was in the range of 31 to 35 years old, one was in the range of 56 to 60 years old, and one was in the range 61 to 65 years old.

The interviewees included two research nurses, one nurse specialist and two nurses working as registered nurses. As to education, three interviewees had obtained a Master's degree, while one had a post-graduate diploma and the other held the highest level of registered general nurse diploma.

With respect to experience, three interviewees were new to the industry and had experience in the range 0 to 5 years, while one had experience in the range 16 to 20 years, and one had been in nursing for more than 26 years.

None of the quotes from the interviews have been attributed to individuals in order to maintain anonymity. A letter was randomly assigned to each interviewee, M, C, R, G and A, to identify the quotes from each individual interviewee.

	n		n
Gender		Primary role	
female	4	only RN	2
male	1	research	2
Age		nurse specialist	1
26~30	2	Highest educational qualification	
31~35	1	Registered General Nurse Diploma	1
56~60	1	Post-Graduate Qualification, Diploma	1
61~65	1	Post-Graduate Qualification, Masters	3
Experience (years)		Current unit	
0~5	3	acute care	1
16~20	1	medical unit	1
26~30	1	psychiatric unit	1
Where are you working?		not in a hospital setting	2
Lothian	4	Previous unit	
Highland	1	critical care	1
		acute care	2
		surgical unit	1
		psychiatric unit	1
		none	1
		other	2
		not in a hospital setting	1

Table 4.8 Demographic data of interviewees. Only RN = working as registered nurse only without any other nursing role.

4.3.2 Knowledge of fever

The questionnaire included seventeen questions concerning fever knowledge (questions 11 to 27). A correct answer scored 1 point, while a wrong answer scored -1 point, and an answer of ‘not sure’ scored 0 points. This negative marking approach ensured that the ‘not sure’ responses were not grouped with incorrect answers. The total knowledge score could range from -17 to 17 where a zero score would represent 50% correct answers. The mean fever knowledge score for all participants was 0.96 with a standard deviation of 4.25 (Table 4.). There were 49% of the participants who scored 0 or below (detailed in Appendix I). Figure 4. shows the distribution of the total knowledge score, with the green line indicating the mean score. The normality of the data was checked beforehand using skewness and kurtosis scores from SPSS (Ghasemi and Zahediasl, 2012; Kim, 2013). As Table 4. shows, the low skewness and kurtosis, indicates that the data approximates a symmetrical and normal distribution. The 95% confidence interval of the mean is 1.59 to 0.33.

Mean		**0.96**
95% Confidence Interval for mean	Lower Bound	0.33
	Upper Bound	1.59
Standard deviation		4.25
Minimum		-11.00
Maximum		11.00
Skewness		-0.07
Kurtosis		-0.22

Table 4.9 Summary of total knowledge scores.

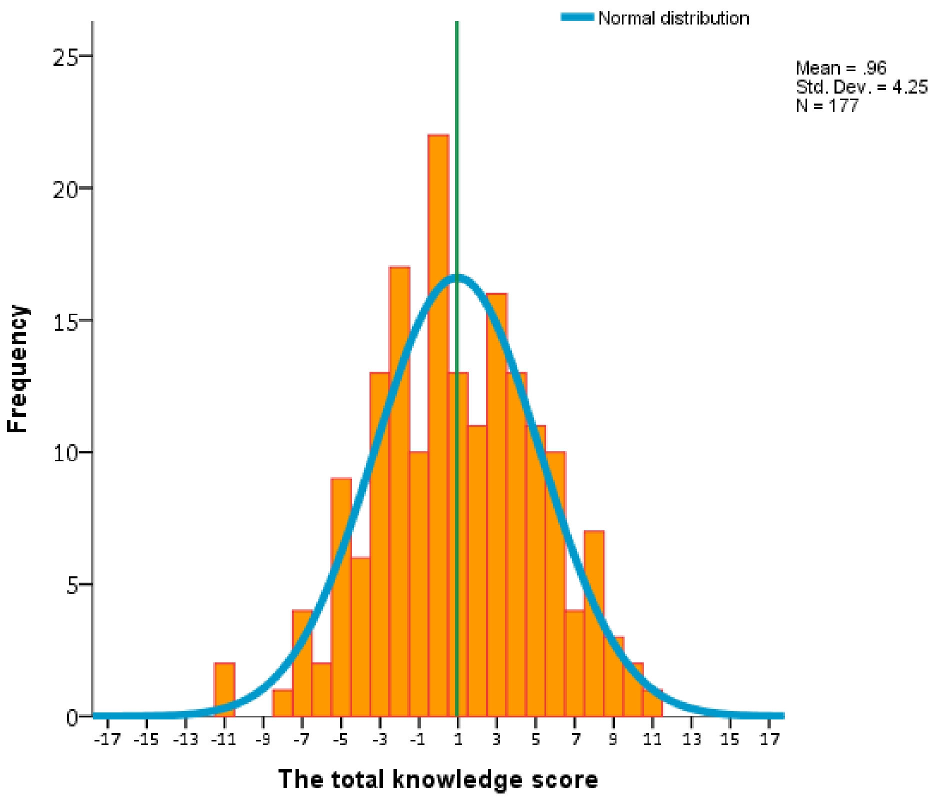

Figure 4.6 The distribution of the total knowledge scores.

Correlations between total knowledge score and other variables such as demographic data were analysed. No significant relationships between total knowledge score and the nurses’ age, experience or highest educational qualification were found (see Table 4). A box plot was used to show the median score and spread of the total knowledge score among participants with different levels of educational qualification (Figure 4.). Each number on the horizontal axis represents a different educational qualification. The median score of the subgroup is indicated by x, while the box shows the interquartile range and the bar the extent. The relationship between different educational qualifications was also analysed. None of the educational qualifications was shown to be significantly correlated with the total knowledge score (see Appendix I).

	Total knowledge score	
	Pearson’s correlation coefficient	**Significance (2-tailed)**
Age	0.041	0.588
Experience	0.104	0.168
	Spearman's rho correlation	**Significance (2-tailed)**
Highest educational qualification	0.120	0.113

Table 4.10 Correlation between age, experience, highest educational qualification and the total knowledge score.

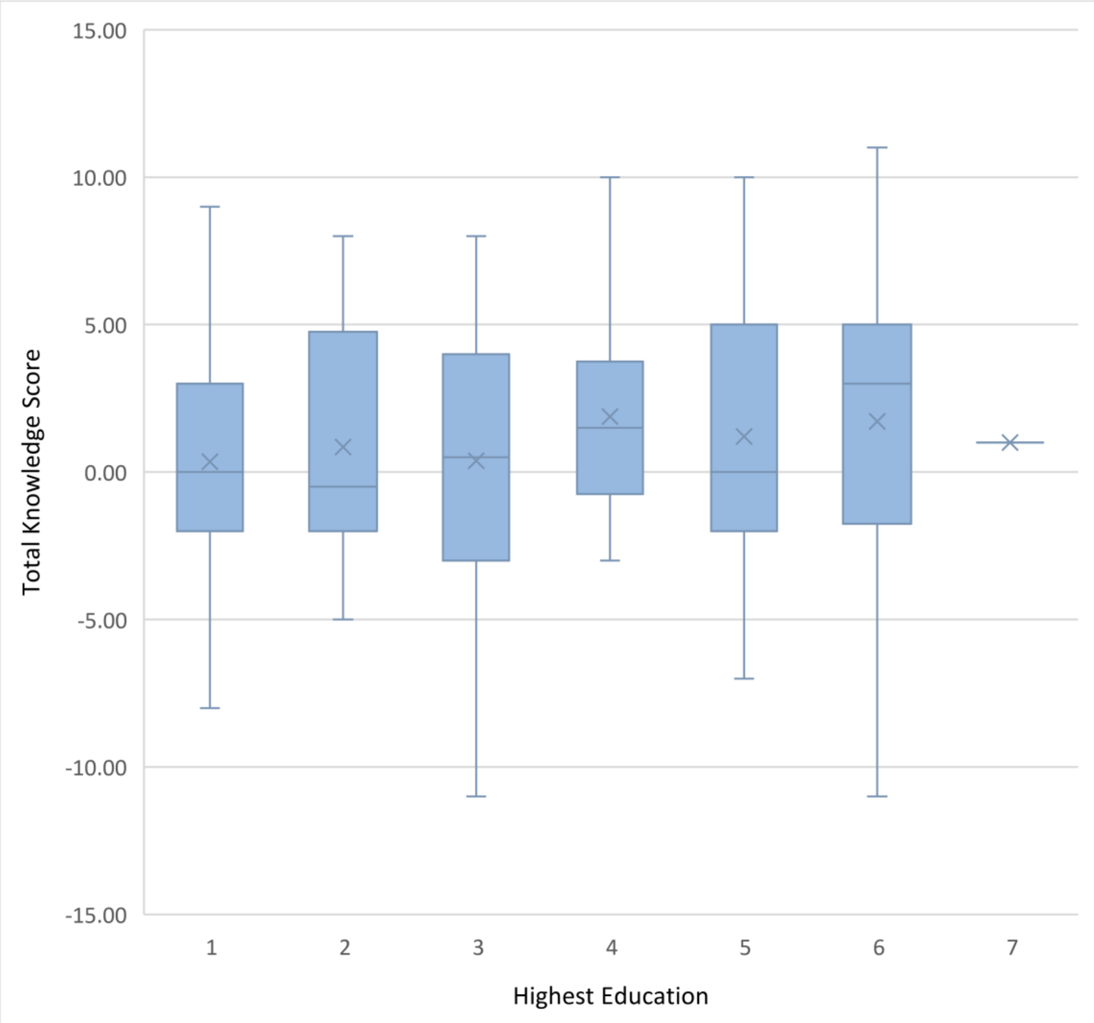

Figure 4.7 Box plot of highest educational qualification and total knowledge score. 1 = State Registration Programme, 2 = Registered General Nurse Diploma, 3 = Nursing Degree BSc/BN, 4 = Nursing Degree BSc Hon/BN Hon, 5 = Post-Graduate Qualification, Diploma, 6 = Post-Graduate Qualification, Masters, 7 = Post-Graduate Qualification, PhD.

Gender and location were also shown to have no significant relationship with total knowledge score (see Table 4. and Appendix I). Differences between clinical setting and total knowledge score were also tested using the Mann-Whitney U test. This revealed that participants who were working in a hospital setting had a significantly higher mean rank ($U = 2824.5$, $p = 0.01$) when compared to all other settings, while participants who were working in the community had a significantly lower mean rank ($U = 1847.5$, $p < 0.0001$) when compared to all other settings (see Table 4 and Appendix I). This finding suggests that participants in the hospital setting had better fever knowledge than participants in the community setting. The clinical setting had more impact on participants' fever knowledge than their level of educational qualification.

Gender	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Female	156	86.64	1270.50	0.09
Male	21	106.50		

Table 4.11 Correlation between the total knowledge score and gender. Asymp. Sig. means asymptotic significance

Setting	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants working in other (non-hospital) settings	66	76.30	2824.50	*0.01
Participants working in a hospital setting	111	96.55		
Participants working in other (non-community) settings	138	95.11	1847.50	*0.00
Participants working in a community setting	39	67.37		

Table 4.12 Correlation between the total knowledge score and different clinical settings. Asymp. Sig. means asymptotic significance, * indicates significant probability.

4.3.2.1 Correlation between experience and knowledge

A significant but weak correlation ($p = 0.012$) was found between the number and variety of units at which participants had worked and their total knowledge score (Pearson's correlation coefficient = 0.190) (see Table). The correlations between different units and total knowledge score were analysed again using the Mann-Whitney U test and the results are shown in Table 4. and Table 4.. Participants who were currently working in acute care, neuroscience or 'other' units had a significantly higher mean rank of total knowledge score ($p \leqq 0.05$), while participants who were currently in a rehabilitation unit or not in a hospital setting had a significantly lower mean rank of total knowledge score ($p \leqq 0.05$). Table 4. shows a considerable difference between the mean rank of participants who were currently working at a neuroscience unit (156.20) and those who were not working at such a unit (87.05), suggesting that nurses working in a neuroscience unit had better fever knowledge than those who were not. The result was also distinctive for participants working in a rehabilitation unit who had a mean rank of 48.25, while those not working in a rehabilitation unit had a mean rank of 90.43, indicating that nurses working in a rehabilitation unit had a lower total knowledge score than those working elsewhere. When analysing the total score with participants' experience, it was found that participants who had experience in critical care, acute care or 'other' units had a significantly higher mean rank on their total knowledge score than those working in a rehabilitation unit or non-hospital setting ($p \leqq 0.05$), (see Table 4.).

	Total knowledge score	
	Pearson's correlation coefficient	Sig. (2-tailed)
Number of units	0.190	*0.012

Table 4.13 The correlation between the number of units at which the participants had worked and their total knowledge score. Sig. means Significance, * indicates significant probability.

Current employment	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants not working in acute care	130	84.17	2426.50	*0.04
Participants working in acute care	47	102.37		
Participants not working in neuroscience	172	87.05	94.00	*0.00
Participants working in neuroscience	5	156.20		
Participants not working in rehabilitation	171	90.43	268.50	*0.05
Participants working in rehabilitation	6	48.25		
Participants not working in the choice of ‘other’ unit	128	84.23	2525.00	*0.04
Participants working in the choice of ‘other’ unit	49	101.47		
Participants working in a hospital setting	121	95.78	2568.00	*0.01
Participants not working in a hospital setting	56	74.36		

Table 4.14 The correlation between participants’ current working units and their total knowledge score. Asymp. Sig. mean asymptotic significance, * indicates significant probability. Participants not working in a hospital setting indicates that participants were working in a non-hospital setting. Therefore, it would be difficult for them to choose a unit.

Past employment	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants who had not worked in critical care	124	79.72	2135.50	*0.00
Participants who had worked in critical care	53	110.71		
Participants who had not worked in acute care	77	72.56	2584.50	*0.00
Participants who had worked in acute care	100	101.66		
Participants who had not worked in rehabilitation	148	92.51	1626.00	*0.04
Participants who had worked in rehabilitation	29	71.07		
Participants who had not worked in the choice of 'other' unit	111	81.66	2848.50	*0.01
Participants who had worked in the choice of 'other' unit	66	101.34		
Participants who had worked in a hospital setting	106	98.81	2723.50	*0.00
Participants who had not worked in a hospital setting	71	74.36		

Table 4.15 The correlation between participants' past work experience at different units and their total knowledge score. Asymp. Sig. means asymptotic significance, * indicates significant probability. Participants not working in a hospital setting indicates that participants were working in a non-hospital setting. Therefore, it would be difficult for them to choose a unit.

The participants' role was also found to be associated with their knowledge score (see Table 4 and Appendix I). This was a multiple-choice question and participants were asked to state all of their current nursing roles. As mentioned, 37.9% of the participants only had the role of registered nurse (see Table 4.). Those 69 participants were found to have a lower mean rank in the knowledge score (U = 2794.5, p = 0.01), while participants who had the role of nurse practitioner were found to have a higher mean rank in the knowledge score (U = 698, p < 0.0001). It was noted that participants who were nurse practitioners had a mean rank of 125.88, while those who were not nurse practitioners had a mean rank of 85.34, this is a significant difference between the two mean ranks. It is argued that nurse practitioners have greater knowledge and expertise

Role	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants working as a registered nurse and in another role	110	97.10	2794.50	*0.01
Participants working only as a registered nurse	67	75.71		
Participants not working as a NP	161	85.34	698.00	*0.00
Participants working as a NP	16	125.88		

Table 4.16 The correlation between participants' nursing role and their total knowledge score. NP means nurse practitioner, Asymp. Sig. means asymptotic significance, * means significant probability

The results indicate that experience in different clinical environments and the different roles of participants ranked among the key elements that can influence the knowledge score. Similar themes emerged from the interviews.

Another theme that came up in the interviews was 'experience of fever leads to knowledge'. Participants believed that different experiences of fever could help to build up their knowledge. It was also found that participants with different areas of expertise, such as critical care nursing, mental health nursing and paediatric nursing, would have different initial thoughts about fever and interpretations of fever. One of the interviewees who had experience in an oncology unit made the following comment.

> *We have patients who have pyrexia because of their disease as well. (C interviewee)*

Her initial interpretations about fever were linked with the patients’ underlying disease, while another interviewee who had experience in a mental health setting regarded fever from another perspective.

> *… it’s in the context of like someone having an adverse reaction to a drug … . Another instance is we’ve had. I’ve had quite a few people who have developed a sepsis which happens because all people get infections. (G interviewee)*

Adverse reaction to a drug was one of the common symptoms in the mental health setting. Therefore, G would associate fever with an adverse reaction to a drug. Besides the effect of drugs, infection was a major cause of fever. The interviewee who was a nurse specialist in the community also related fever to infection.

> *It’s the body’s reaction to infection or bacteria of some kind, or viral. (A interviewee)*

Another interviewee who was working in a critical unit thought fever was often related to surgery.

> *I think in the unit that is seen as that will probably happen just after surgery. (R interviewee)*

The interviewees’ initial interpretations about fever tended to be closely related to their clinical experience, especially their clinical environment and clinical setting. This could be an explanation of the significant correlation found between varieties of units and the total knowledge score from the questionnaire.

Although the relationship between the length of experience and the total knowledge score was not significant, participants in the interviews had different thoughts about the relationship between the length of experience and knowledge about fever.

> *It is the general kind of thing that you gradually build up, isn't it, over time with experience. (C interviewee)*

> *Obviously, the more experienced you get, the more you retain. The more information you have at your fingertips. (M interviewee)*

They believed that greater knowledge would come with more experience. Accordingly, most of the participants mentioned their training or education when talking about fever knowledge. The analysis revealed that education or training allowed nurses to learn about fever; however, it was their practical experience that helped interviewees to grasp the significance of the fever knowledge as identified by R and G in the following quotes.

> *A simple thing like looking at blood results, when I first started and we did blood results, I didn't really understand but now, I do. Looking back, I know at university you learn about all that, but it's taken me a while to be able to practically apply it. (R interviewee)*

> *… which is all scenario learning. So when it does happen in real life, you know, you kind of automatically start … [the decision making process] … . I think it comes from our educational background … . (G interviewee)*

These extracts indicate that the main route of knowledge acquisition was through education of any sort. However, hands-on experience served to prompt the recall of knowledge and the ability to apply the knowledge. In this way, the experience of fever could help to improve fever knowledge.

4.3.2.2 Overall score on knowledge of fever

In order to explore what the nurses knew about fever, several individual questions were analysed. The answer to each question was categorised into one of three scores: 1 point for a correct answer, -1 for a wrong answer and 0 for ‘not sure’. Table 4 shows the mean score for each fever knowledge question. Appendix B presented the details of the questionnaire. Looking at individual questions, question 23, about correct paracetamol dosage, was found to have the highest mean score: 0.62. In question 23, none of the participants were unsure about the answer, which indicated that participants were confident with their answer. Question 18, which asked about the temperature they would define as the onset of fever, had the lowest mean score: -0.68. Question 19 also asked about the temperature of fever. That question, which concerned the body temperature at which brain damage would result, had the third lowest mean score: -0.50. It would seem that there was a concern about participants’ knowledge of the definition of fever and the degree of temperature that would cause brain damage. The second lowest mean score was question 27, about the disadvantages of fever; its mean score was -0.49. As to questions about the causes of fever, the number of participants who answered these questions correctly was roughly the same as the number of those who answered them incorrectly. Interestingly, most of the participants were quite confident when answering the questions about the explanation of increased body temperature. Only two people selected ‘not sure’ for question 11, while only one person chose ‘not sure’ for question 13. When asked about the association between temperature and other vital signs, such as breathing rate and heart rate, the number of participants who answered correctly was roughly the same the number of people who answered question 14 and question 15 incorrectly or were not sure about the answer. Questions about the side effects of antipyretics were also included in the questionnaire. Question 21 and 24 both concerned pharmacological antipyretics, while question 22 asked about physical antipyretics. Only a few participants were 'not sure' about the side effects of pharmacological antipyretics (questions 21 and 24), while 15 participants were 'not sure' about the side effects of physical antipyretics. Participants tended to be more confident about pharmacological antipyretics compared with physical antipyretics. Interestingly, more people answered correctly about side effects of antipyretics medication, with a mean score of 0.34 and 0.62, while more people answered incorrectly about physical antipyretics, for which the mean score was -0.11. Among all the questions, question 26 had the most 0 scores. 48% of the participants were 'not sure' about the answer. The question asked about the benefits of fever. It could be concluded that participants did not know about the benefits of fever.

Categories of fever knowledge questions		-1	0	1	Mean Score
	Question	n(%)			
Reasons of fever	11	98(55.4)	2(1.1)	77(43.5)	-0.12
	12	83(46.9)	19(10.7)	75(42.4)	-0.05
	13	78(44.1)	1(0.6)	98(55.4)	0.11
Temperature association with vital sign	14	49(27.7)	58(32.8)	70(39.5)	0.12
	15	60(33.9)	52(29.4)	65(36.7)	0.03
Measurement of temperature	16	82(46.3)	8(4.5)	87(49.2)	0.03
Rationale of antipyretics	17	21(11.9)	69(39)	87(49.2)	0.37
	20	45(25.4)	51(28.8)	81(45.8)	0.34
Fever temperature	18	130(73.4)	37(20.9)	10(5.6)	-0.68
	19	87(49.2)	46(26.0)	44(24.9)	-0.24
Side effects of antipyretics	21	54(30.5)	4(2.3)	119(67.2)	0.37
	22	91(51.4)	15(8.5)	71(40.1)	-0.11
	24	56(31.6)	3(1.7)	118(66.7)	0.35
Using paracetamol	23	34(19.2)	0(0.0)	143(80.8)	0.62
Fever benefits and disadvantages	25	23(13.0)	42(23.7)	112(63.3)	0.50
	26	51(28.8)	85(48)	41(23.2)	-0.06
	27	128(72.3)	7(4.0)	42(23.7)	-0.49

Table 4.17 The scores for individual questions.

The inter-item correlation matrix is usually used to check the consistency of questions in a questionnaire (Bobko, 2001; Chen and Popovich, 2002; Quirk and Cummings, 2017; Burdess, 2010; Ben-Zvi et al., 2018). However, the reliability of this questionnaire had already been examined. As a result, the inter-item correlation matrix was used to find the predictors of the total knowledge score. Table 4.181 demonstrated the result of inter-item correlation between the total knowledge score and each fever knowledge question. Questions 15, which had the lowest total knowledge score, and 20, which had the highest, were found to be predictors of the total knowledge score (see Table 4.181). By using Pearson's correlation coefficient, it is significant ($p < 0.0001$) that participants who answered question 20, which was referring to the antipyretics mechanism, correctly had a high total knowledge score. The correlation is moderate (0.47) as in Table 4.. However, the correlation between question 15 and the total knowledge score is not significant (see Table 4.).

	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Total knowledge score	0.352	0.205	0.309	0.234	0.068	0.337	0.266	0.256	0.357	0.470
	Q21	**Q22**	**Q23**	**Q24**	**Q25**	**Q26**	**Q27**	**Q20**	**Q21**	
Total knowledge score	0.352	0.200	0.180	0.323	0.296	0.326	0.378	0.470	0.352	

Table 4.181 The inter-item correlation matrix.

		Q15	Q20	Not sure
Total knowledge score	Pearson's Correlation Coefficient	0.068	*0.470	-0.148
	Significance (2-tailed)	0.371	0.000	0.050

Table 4.19 Pearson's correlation coefficient for questions 15 and 20 and the 'not sure' option with the total knowledge score. * indicates significant probability

The correlation between each question was also analysed. The knowledge questions were categorised into different themes in order to discover whether questions concerning similar elements of fever were related. By using Pearson's chi-square test, associations between individual questions were found. The answers to each of the questions were categorised into either a correct answer or an incorrect answer. The reason for categorising the answer into two types was to create a 2 X 2 table in order to reduce the number of cells with a value less than 5. Questions 11, 12 and 13 were all concerned with the causes of fever. However, a significant relationship was found between question 11 and question 13 (value (1) = 5.049, p = 0.025). The figures in Table 4. show that participants who answered question 11 correctly were more likely to answer question 13 correctly. Their phi statistic is 0.169, which indicates a weak association. Question 16, which asked about the measurement of temperature, was found to be significantly associated (value (1) = 7.076, p = 0.008) with question 18, which concerned the definition of fever. The phi statistic was also weak at 0.200 (see Table and Appendix J). Questions 20, 21, 23 and 24 all concerned the pharmacological antipyretics. Among those questions, only questions 20 and 24 had a significant association (value(1) = 6.556, p = 0.010) with a phi statistic of 0.192 (see Table 4.22 and Appendix J). Question 20 referred to the mechanism of pharmacological antipyretics, while question 24 asked about the side effects of antipyretics. Questions 21 and 24 both asked about the side effects of antipyretics, the only difference between these two questions was some of the choices within the questions. Not surprisingly, questions 21 and 24 were found to be significantly related (value (1) = 18.516, $p < 0.0001$). Their phi statistic is 0.323 (Table 4.22). Although the association between these two questions is stronger, the coefficient is weak. Questions 25 and 26 both asked about the benefits of fever, and the two questions are significantly ($p = 0.003$) associated. Their phi statistic is 0.224 (Table 4.). Interestingly, when analysing questions 25 and 26 with respect to question 27, about the disadvantages of fever, the result indicated no significant association (see Appendix J). Apparently, the participants did not link the benefits and the disadvantages of fever. These associations discussed above, were the only ones that were found to be significant in the results from the questionnaire. The other groups of questions (as categorised in Table 4), such as those relating temperature with vital signs, rationale for administering antipyretics, and fever temperature, were all found to have no significant associations among the questions (see Appendix J). This result indicates a lack of overall knowledge about fever among nurses.

Q11xQ13			Q 13		Pearson's chi-square test	
			-1	1		
Q 11	-1	Count	52	48	Value	5.049
		Expected Count	44.6	55.4	df	1.000
	1	Count	27	50	Asymp. Sig. (2-sided)	*0.025
		Expected Count	34.4	42.6		
Nominal by Nominal			Phi			0.169

Table 4.20 Q11 and Q13 cross tabulation. 1 indicates correct answers, -1 indicates wrong answers, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability.

Q16xQ18			Q18		Pearson's chi-square test	
			-1	1		
Q16	-1	Count	89	1	Value	7.076
		Expected Count	84.9	5.1	df	1.000
	1	Count	78	9	Asymp. Sig. (2-sided)	*0.008
		Expected Count	82.1	4.9		
Nominal by Nominal			Phi			0.200

Table 4.21 Q16 and Q18 cross tabulation. 1 indicates correct answers, -1 indicates wrong answers, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability

Q20xQ24			**Q24**		**Pearson’s chi-square test**	
			-1	1		
Q20	-1	Count	40	56	Value	6.556
		Expected Count	32.0	64.0	df	1
	1	Count	19	62	Asymp. Sig. (2-sided)	*0.010
		Expected Count	27.0	54.0		
Nominal by Nominal			Phi			0.192
Q21xQ24			Q24		Pearson’s chi-square test	
			-1	1		
Q21	-1	Count	32	26	Value	18.516
		Expected Count	19.3	38.7	df	1
	1	Count	27	92	Asymp. Sig. (2-sided)	*0.000
		Expected Count	39.7	79.3		
Nominal by Nominal			Phi			0.323

Table 4.22 Q20, Q21 and Q24 cross tabulation. 1 indicates correct answers, -1 indicates wrong answers, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability.

Q25xQ26			Q26		Pearson's chi-square test	
			-1	1		
Q25	-1	Count	58	7	Value	8.867
		Expected Count	49.9	15.1	df	1
	1	Count	78	34	Asymp. Sig. (2-sided)	*0.003
		Expected Count	86.1	25.9		
Nominal by Nominal			Phi			0.224

Table 4.23 Q25 and Q26 cross tabulation. 1 indicates correct answers, -1 indicates wrong answers, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability

One of the participants (number 8) who completed the questionnaire had thoughts about whether nurses should know more about fever.

> *Even for someone with critical care knowledge and having done a Masters dissertation on sepsis - some of the questions were far too technical for nurse. (Participant 8, questionnaire)*

Most of the participants in the interviews, however, had a somewhat different opinion. They did not feel they had sufficient knowledge about fever; indeed, they felt that they should know more about fever, as G explained.

> *… and that's all I kind of feel that I kind of know. In terms of the pathophysiology of it, I probably don't have enough knowledge. (G interviewee)*

The data shows that most of participants were not satisfied with their knowledge about fever. In particular, they would like to know more about pyrexia. The explanation for their not feeling knowledgeable about fever was their ‘confidence about fever knowledge’, as themed in the qualitative data. All of the interviewees indicated confidence in their knowledge of fever prior to completing the questionnaire. Interviewee C expressed confidence in her fever knowledge, especially when managing fever.

> *I have never really come across anything where I have thought, ‘No—’. (C interviewee)*

It was clear that the participant was certain about her management and knowledge of fever. However, after completing the questionnaire, the interviewees became concerned about their knowledge about fever, as evidenced by the following excerpts.

> *It made me think I don’t know that much about fever. (R interviewee)*

> *… and realise that my lack of knowledge was. Yes. Completely. (C interviewee)*

The nurses’ feelings about their lack of knowledge about fever were highlighted in the interviews. The questionnaires presented a similar result. Table 4. shows the correlation between the number of ‘not sure’ responses and the total knowledge score. The relationship between the total number of the ‘not sure’ responses in the fever knowledge questions and the total knowledge score were examined by using Pearson’s correlation coefficient. The result also showed a significant ($p = 0.05$) negative correlation between total numbers of ‘not sure’ response in fever knowledge questions and total knowledge score. This indicated if a participant stated more ‘not sure’ in the fever knowledge part of the questionnaire, the more likely the participant would have a lower score. It was found that the correlation between those two variables was weak (-0.148) (see Table 4.). It is noteworthy that the negative correlation between the total knowledge score and the number of ‘not sure’ responses revealed that nurses were confident about their fever knowledge most of the time, they had not expanded or updated their knowledge and were unaware that they lacked knowledge about the current best practice for managing fever. This finding suggests that the feeling of not having enough fever knowledge would be one of the keys to motivate nurses and other care givers to learn more.

	Total knowledge score	
Not sure	Pearson Correlation	-0.148
	Sig. (2-tailed)	0.050

Table 4.24 Correlation between the number of 'not sure' and total knowledge score. Sig indicates significance

4.3.2.3 Definition of fever, thoughts about fever

The definition of fever was identical among the interviewees. Most of the interviewees would start to observe a patient's temperature closely when the temperature was about to reach 38℃. Take the following conversation for example.

> *But then I guess, if they had been 37.9 or 37.8, if you looked at it then, they might not have got to 38. (R interviewee)*
>
> *Yes. I guess your definition for fever is 38℃? (Interviewer)*
>
> *Yes. If it was persistently 37.8 or 37.9, if it was persistent, then yes. Over 38. (R interviewee)*

Another interviewee had a similar thought about the definition of fever.

> *But if it's something like somebody has just got a temperature, say that is 37.8 or 37.9 and they're a wee bit flushed, but*

> *they're actually okay … . If somebody had a temperature over 37.6, and certainly in the 38s, then you would be thinking 'We need to deal with this'. (M interviewee)*

Further discussion about the degree of temperature elevation at which interviewees would decide to start to manage fever appears in the following paragraphs. Infection was a theme that often occurred when talking about fever, especially concerns about sepsis. Take the following quotation for example.

> *It's either sepsis, a similar sort of infection. (G interviewee)*

Looking at both the degree of temperature accepted as fever and the degree of temperature to manage fever, 38℃ definitely played an important role. Despite the temperature level, the underlying cause of fever was also one of the key elements influencing the decision-making process to commence managing the fever. Participants revealed that if it was suspected that the fever was related to sepsis, interventions would be undertaken to control body temperature.

4.3.2.4 Access to new information.

Since the development of the Sepsis Six bundle by the NHS (see Chapter 1), clinicians have recognised a strong connection between sepsis and fever. However, in a world awash with information, most of the interviewees were worried that they could not keep up with the latest scientific evidence. The participants expressed their nervousness as follows.

> *There have been a lot of changes in 45 years. (A interviewee)*

> *It is very difficult to keep on top of all that (fever knowledge). (G interviewee)*

Accordingly, a need to gain access to the latest scientific evidence was raised among the interviewees.

> *These things change over the years as well. What we think is a way to manage something when we finished our nursing training, 10 years later it is totally out of date. Do we know where to go to find out the current best practice for it? (M interviewee)*

Another interviewee raised a similar issue. Concerning fever training, she commented as follows.

> *Personally, I’ve never come across one [training course] about fever. (A interviewee)*

In general, the participants expressed a need to enhance nurses’ fever knowledge; they found it difficult, however, to update their fever knowledge or to gain access to proper knowledge sources.

4.3.2.5 Factors linked to fever knowledge

A concern about the lack of overall knowledge about fever was highlighted in results from the questionnaire. Only a few factors were found to be associated with the total knowledge score. Experience in different clinical environments was one of the factors discovered to be significantly associated with total knowledge score. It was also one of the themes that came up in the interviews ‘experience in fever leads to the knowledge’. Although the length of experience was not found to be statistically significant in the results from the questionnaire, participants thought the length of nursing experience was related to enhanced fever knowledge. Experience in different clinical environments was also associated with total knowledge score. It appeared that different types of medical units had different perspectives regarding the treatment of fever. Accordingly, more experience in different units was found to be significantly related to fever knowledge. Interestingly, while the participants were quite confident about their fever knowledge initially; once they completed the questionnaire most of the interviewees thought they needed to acquire more fever knowledge. Misplaced confidence could be identified as a potential obstacle to seeking to acquire or update fever knowledge. Although the interviewees had different areas of expertise and different nursing backgrounds, most of them related fever to infection or sepsis. When fever was thought to be related to infection, most of the nurses would decide to intervene and treat the fever. As to the interventions used to manage fever, the questionnaire results showed that participants knew that paracetamol is a widely used antipyretic, although their knowledge about defining fever was poor. The nurses found it difficult to keep themselves updated about the latest evidence-based practices, especially since new healthcare information is publicised daily.

4.3.3 Thoughts about fever

More than 80% of the participants thought controlling body temperature during fever could reduce hospital stay (n = 149) and reduce mortality (n = 153). Table 4. shows that only 11 participants thought controlling fever could increase mortality as well as hospital stay. The relationship between those two questions was analysed using Pearson’s chi-square test. In the analysis, the ‘not sure’ option and the ‘increase stay’ option were placed in the same category to avoid bias. Table 4. highlights that those two questions have a significantly (value (1) = 83.667, $p < 0.0001$) strong correlation (phi statistic = 0.688).

28. Controlling body temperature during fever can:	n	Percentage(%)
Increase hospital stay	11	6.21
Not sure	17	9.60
Reduce hospital stay	149	84.18
29. Controlling body temperature during fever can:	**n**	**Percentage(%)**
Increase mortality	11	6.21
Not sure	13	7.34
Reduce mortality	153	86.44

Table 4.25 Descriptive data of Q28 and Q29

Q28xQ29			**Q29**		**Pearson's chi-square test**	
			-1[a]	1[b]		
Q28	-1[c]	Count	19	9	Value	83.667
		Expected Count	3.8	24.2	df	1.000
	1[d]	Count	5	144	Asymp. Sig. (2-sided)	*0.000
		Expected Count	20.2	128.8		
Nominal by Nominal			Phi			0.221

Table 4.26 Cross tabulation of Q28 and Q29. [a] indicates increase mortality + not sure, [b] indicates reduce mortality, [c] indicates increase hospital stay + not sure, [d] indicates reduce hospital stay, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability

However, not all participants believed that treating fever could reduce hospital stay. In the questionnaire, participant 13 expressed her concern that controlling fever might prolong the length of an illness.

> *I have been under the impression and the guideline states that paracetamol should not be used to reduce temperature but for pain, but a lot of clinicians are still telling patients to get the temp down. I was under the impression that it was the body's response to kill the infection and if we took the temp down the infection could last longer. It would be good to have guidelines that we all followed. (Participant 13, questionnaire)*

In this statement, participant 13 revealed her understanding of the current guidelines for managing fever and the benefits of fever; however, she also suggested that not all health workers adhere to the guidelines. Hence, she proposed that clearer guidelines for clinicians should be formulated. The data indicate a gap between the guidelines and current practice. A question asked if clinicians were aware of the guidelines for administering antipyretics or had simply disagreed with the guidelines. The absence of clear guidance for using antipyretics indicated in the study suggests that nurses might not have the correct information for the proper use of antipyretics. Current evidence indicates that utilising antipyretics during fever might not decrease patients' hospital stay and morbidity (Mohr et al., 2012; Niven et al., 2013; Janz et al., 2015; Rockett et al., 2015; Young et al., 2015). Indeed, many studies suggest that controlling body temperature might prolong illness. Accordingly, the relationship between participant thoughts about fever management (Q28 and Q29) and total knowledge score was analysed using the Mann-Whitney U test. A significant correlation ($U = 1459.50$, $p = 0.012$) was found showing that participants who thought controlling fever would reduce the hospital stay had a lower mean rank total knowledge score than those who thought otherwise (see Table 4.). The mean rank was 111.38 for participants who believed controlling fever could increase hospital stay and participants who were not sure whether controlling fever would affect hospital stay; while the mean rank for participants who believed controlling fever could decrease hospital stay was 84.80 (Table 4.). The findings suggest that participants who thought managing fever could decrease hospital stay tended to have a lower total knowledge score.

		n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2- tailed)
Q28	Prolong+ not sure	28	111.38	1459.500	*0.012
	Reduce hospital stay	149	84.80		
Q29	Prolong+ not sure	24	102.85	1503.500	0.153
	Reduce mortality	153	86.83		

Table 4.27 Correlation between Q28, Q29 and the total knowledge score. Asymp. Sig. mean asymptotic significance, * indicates significant probability.

4.3.4 Fever management

The questionnaire was also designed to gather information about knowledge on fever management. Table 4. lists the different types of thermometer that were used in the participants' clinical settings. More than 88% of the participants used tympanic membrane thermometers in their clinical settings. The second most commonly used thermometer in the clinical settings was the oral thermometer, used by 37 participants in their clinical settings. Axillary thermometers (n = 36) were also quite commonly seen in the clinical settings. It is worth noting that more than 65% of participants only had one type of thermometer in their clinical settings, while about 30% of participants had two to three types of thermometers available for use (Table 4.). Among the 117 participants who only had one type of thermometer in their clinical setting, 101 (86.3%) used tympanic membrane thermometers in their healthcare environment.

The number of temperature monitoring methods was compared with the answers to question 16, which asked about temperature measurement. Surprisingly, the results indicated that there was no significant correlation between the two variables (Table 4.302). Also, the results of a correlational analysis between the number of monitoring methods and answers to questions 18 and 19 about definition of fever temperature showed no significant association between the two (Table 4.302). It can be concluded that having access to different types of thermometers had no significant association with knowledge about fever temperature.

Thermometer	n	Percentage (n=272)[a]	Percentage (n = 177)[b]
Oral	37	0.14	0.21
Tympanic membrane	156	0.57	0.88
Temporal artery	5	0.02	0.03
Rectal	18	0.07	0.10
Pulmonary artery thermometer catheter	2	0.01	0.01
Urinary bladder thermometer catheter	0	0.00	0.00
Brain thermometer	1	0.00	0.01
Axillary	36	0.13	0.20
None of the above	12	0.04	0.07
Other	5	0.02	0.03
Total	272		

Table 4.28 Different thermometers available for use in clinical settings. [a] indicates the Percentage calculated by dividing the total frequency of the methods (n = 272), [b] indicates the Percentage was calculated by dividing the samples (n = 177).

Number of temperature monitoring methods	n	Percentage(%)
1	117	66.10
2	33	18.64
3	20	11.30
4	7	3.95

Table 4.29 Results of numbers different types of body temperature monitoring methods.

	Q16		Q18		Q19	
	Pearson Correlation	Sig. (2- tailed)	Pearson Correlation	Sig. (2- tailed)	Pearson Correlation	Sig. (2- tailed)
number of methods	0.112	0.138	0.136	0.071	- 0.037	0.628

Table 4.302 Correlation between Q16, Q18, Q19 and number of different body temperature monitoring methods. Sig means significance.

As mentioned, one of the keys for participants to decide when to manage fever was the guidelines. The questionnaire, therefore, surveyed whether their institutes or units had a protocol to follow for fever management. The institute was referring to clinical setting, such as hospital, clinic, medical centre, department of community care, etc. Whereas the unit was referring to critical care, medical unit, surgical unit, psychiatric unit, etc. Figure 4. demonstrated the result of Question 36: Does your hospital/institution have an explicitly written fever/hyperthermia management protocol for patients with fever? About 45% of the participants did not know whether their hospital or institute had a fever management protocol. Only 23% of participants said there was a fever management protocol in place at their hospital or institute (Figure 4.). More participants were uncertain when asking about if their units, such as critical care, paediatric unit, medical unit and so forth, had fever management guideline. Figure 4. showed the result of Question 37: Does your unit have an explicitly written fever/hyperthermia management protocol for patients with fever? Almost 50% of the participants had not heard of a fever management protocol at their unit, while 14% of the participants stated that their unit had a fever management protocol (see Figure 4.). The correlation between question 36 and 37 and total knowledge score was investigated using the Mann-Whitney U test. Table 4.31 Correlations between the Q36, Q37 and the total knowledge score. Asymp. Sig. means asymptotic significance, * indicates significant probability. Table 4. shows that there was no significant correlation found between the presence of a protocol in the hospital or unit and total knowledge score.

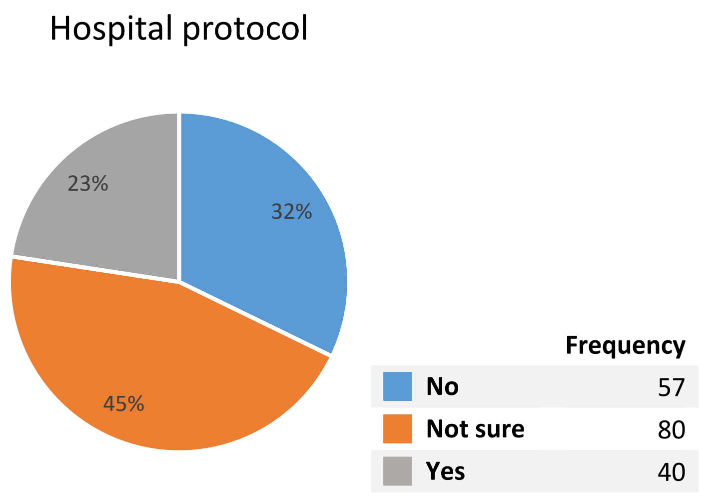

Figure 4.8 Question 36. Does your hospital/institution have an explicitly written fever/hyperthermia management protocol for patients with fever?

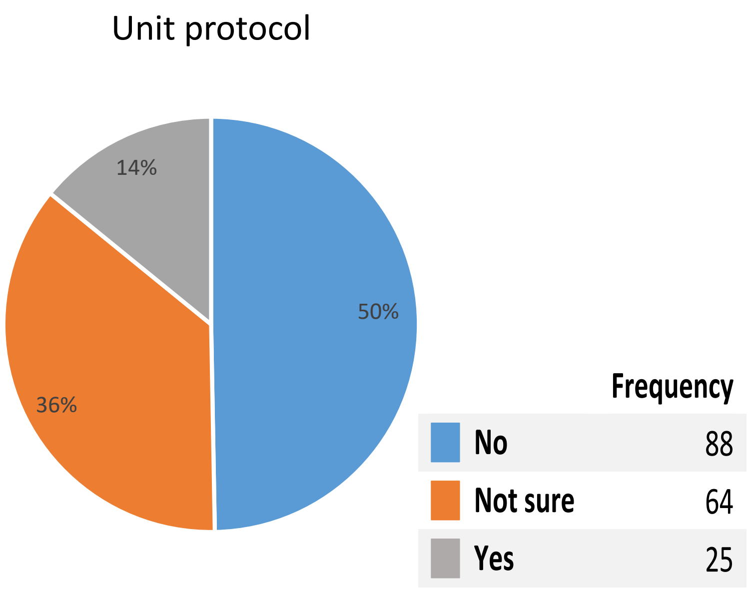

Figure 4.9 Question 37. Does your unit have an explicitly written fever/hyperthermia management protocol for patients with fever?

Hospital/Unit protocol	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2- tailed)
Participants who did not have a hospital protocol	137	91.71	2368.50	0.191
Participants who had a hospital protocol	40	79.71		
Participants who did not have a unit protocol	152	91.67	1493.50	0.086
Participants who had a unit protocol	25	72.74		

Table 4.31 Correlations between the Q36, Q37 and the total knowledge score. Asymp. Sig. means asymptotic significance, * indicates significant probability.

In the previous paragraphs, a recommendation to develop fever guidelines for clinicians was proposed.

> *I have been under the impression and the guideline states that paracetamol should not be used to reduce temperature but for pain, but a lot of clinicians are still telling patients to get the temp down. I was under the impression that it was the body's response to kill the infection and if we took the temp down the infection could last longer. It would be good to have guidelines that we all followed. (Participant 13, questionnaire)*

Both the qualitative and quantitative data indicate a gap between the guidelines and current practice. An initial puzzle was whether or not clinicians were aware of the guidelines for administering antipyretics or did they just disagree with the guidelines. However, after analysing the correlation between existing protocols and total knowledge score, there was no association found between knowing about the guidelines and having a better total knowledge score. The explanation could be that nurses had beliefs which were not in line with the guidelines or they misunderstood the guidelines. Therefore, a gap between fever knowledge and a willingness to follow the guidelines was created. The lack of fever knowledge could have serious consequences for fever management.

Besides asking about existing protocols, the questionnaire also explored the decision-making process that participants followed when they encountered fever, the results are shown in Figure 4.. The majority of participants chose independent nursing judgement when it came to decision making in fever management. There were 27 participants who would made their decision whether to commence fever management depending on medical directions, while 28 participants made their decision according to the national guidelines (see Figure 4.). Although only 25 of the participants stated that their units had a fever management protocol, 21 participants would follow the unit protocol when making a decision to manage fever. As discussed, participants who were aware of the protocol would tend to manage fever according to those guidelines. It would, thus, be reasonable to speculate whether the participants might have misunderstood or misinterpreted the protocols. The Mann Whitney U test was used to compare the rationale of decision making in fever management and total knowledge score; the result showed no significant correlation between these two variables (see Table 4.). The finding could be evidence that participants who depended on a protocol to manage fever might have misunderstood the guidelines. The use of protocols for fever management is discussed in Section 4.3.4.1. The results in Table 4. also show there was no significant association between the use of independent judgement as the primary rationale for fever management and total knowledge score. The rationale of the participants’ decision making was examined with questions 28 and 29, which asked about the participants’ thoughts about controlling fever. Using a chi-square analysis, only a few significant correlations were found (see Table 4., Table 4. and Appendix J). Table 6.36 included the result of the likelihood ratio, due to many subgroups had the count less than 5. Therefore, using the likelihood ration would provide a more precise result than Pearson’s chi-square test. It was shown to be significant ($p \leq 0.05$) that participants who did not choose ‘other’ for their decision making on fever management were more likely to think controlling fever could reduce mortality and hospital stay (hospital stay: Value(2) = 6.565, $p = 0.038$; mortality: Value(2) = 6.693, $p = 0.035$). However, the correlation between those variables was weak (phi < 0.25).

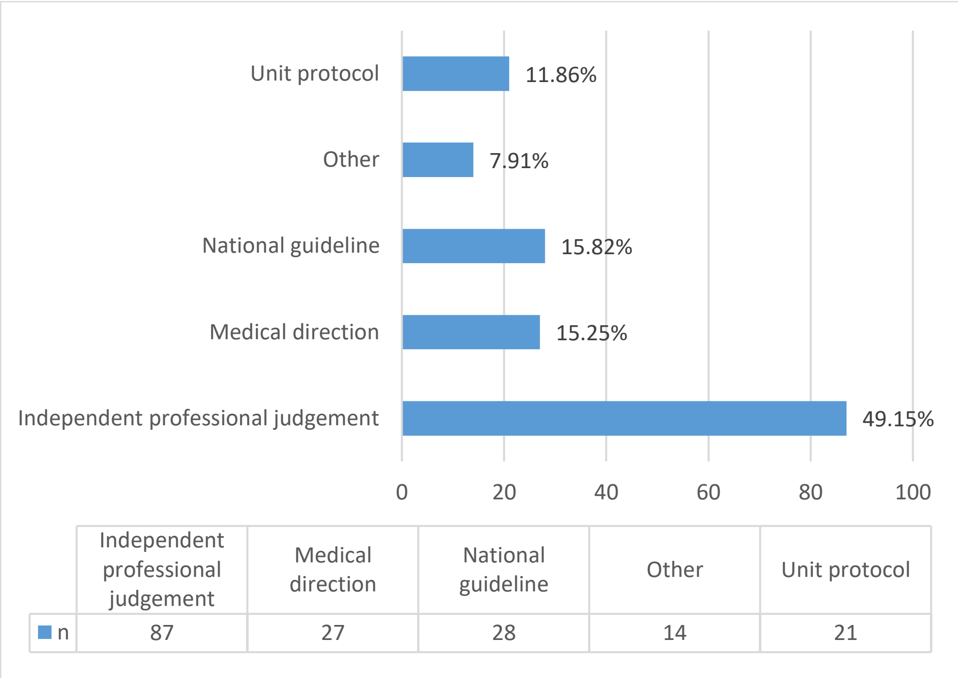

Figure 4.10 Question 35. What is your primary rationale for initiating treatment at this temperature?

Rationale	N	Mean Rank	Mann-Whitney U	Asymp. Sig. (2- tailed)
Not using medical direction as primary rationale	150	89.97	1879.00	0.55
Using medical direction as primary rationale	27	83.59		
Not using independent nursing judgement as primary rationale	90	88.77	3894.50	0.95
Using independent nursing judgement as primary rationale	87	89.24		
Not using national guideline as primary rationale	149	90.15	1914.00	0.49
Using national guideline as primary rationale	28	82.86		
Not using unit protocol as primary rationale	156	87.98	1478.50	0.47
Using unit protocol as primary rationale	21	96.60		
Not using the 'other' option as primary rationale	163	88.15	1003.00	0.45
Using the 'other' option as primary rationale	14	98.86		

Table 4.32 Correlations between rationales of decision making on fever management and the total knowledge score. Asymp. Sig. means asymptotic significance.

Q28, Decision making			Other		Pearson's chi-square test		Likelihood Ratio
			0	1			
Q28	Increase hospital stay	Count	9	2	Value	8.608	6.565
		Expected Count	10.1	0.9	df	2	2
	Not sure	Count	13	4			
		Expected Count	15.7	1.3			
	Reduce hospital stay	Count	141	8	Asymp. Sig. (2- sided)	*0.014	*0.038
		Expected Count	137.2	118			
Nominal by nominal				Phi			0.221

Table 4.33 Correlations between question 28 and rationale of decision making on fever management using cross tabulation. 1 indicates choosing the option 'other' as their rationale of decision making, 0 means not used 'other' as rationale of decision making, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability.

Q29, Decision making			Other		Pearson's test	chi-square	Likelihood Ratio
			0	1			
Q29	Increase mortality	Count	10	1	Value	10.211	6.693
		Expected Count	10.1	0.9	df	2	2
	Not sure	Count	9	4			
		Expected Count	12.0	1.0			
	Reduce mortality	Count	144	9	Asymp. Sig. (2- sided)	*0.006	*0.035
		Expected Count	140.9	12.1			
Nominal by nominal			Phi				0.24

Table 4.34 Correlations between question 29 and rationale of decision making on fever management using cross tabulation. 1 indicates choosing the option 'other' as their rationale of decision making, 0 means not used 'other' as rationale of decision making, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability

4.3.4.1 Elements that influence fever management

Influences from the clinical environment

Further discussion about the rationale of fever management was conducted in the interview. Most of the interviewees agreed that they use their own independent professional judgement when managing fever. The clinical routine for managing fever embedded in each unit was found to be one of the key factors that impacted the participants' decision-making process. The clinical culture also exerted a strong influence on the nurses' initial interpretations about assessing and responding to fever. This was highlighted by R.

> *I remember asking a colleague once. Somebody had a fever and they were like, ‘Okay. Give them paracetamol.’ I said, ‘Won’t that mask the symptoms?’ They said, ‘Yes. But they’re going to be really uncomfortable. The fever is going to make them feel really uncomfortable, so you should make them feel comfortable by giving them paracetamol.’ (R interviewee)*

R mentioned the influence of her colleagues. Interestingly, although she was not totally convinced by what her colleague had said, she still managed the patient fever according to their advice. This shows that clinical culture exerted a strong impact on individual nurses in their decision making. The nurses’ clinical routines also influenced fever management. M’s statement offers a case in point.

> *Sometimes patients will have come back from theatre, from a procedure, and they have missed a dose of medication because they’ve been in theatre. You go, ‘Oh, you’ve got a wee fever, but you’ve not had your paracetamol.’ So we can give it then. (M interviewee)*

Regular paracetamol is prescribed for pain relief (e.g. after surgery) both to maintain a constant level of analgesia and also to reduce the amount of opioids needed. M explained this scenario in his statement above. Although the main purpose for providing paracetamol was to manage pain, some participants considered not taking antipyretics itself to have been the cause of fever. Likewise, R made a similar comment about a surgical situation.

> *When he came back from theatre, checking his temperature every hour to see if there was any change. I made sure he was on regular paracetamol. (R interviewee)*

Again, when discussing fever management, R spoke about the routine of administering paracetamol to a patient after surgery. His comment shows that the participants easily confused the reason for prescribing regular antipyretics after surgery with the cause of fever. It was a common among the nurses that not having regular paracetamol was the underlying cause of fever, illustrating the influence of clinical routines on fever management decisions. An interviewee who worked in an oncology unit had a different approach to fever. C's remark below reveals how different clinical environments Influence the way nurses apply their knowledge in practice.

> *So I think temperature is one of the key things that we look out for with our observations because of the risk of neutropenic sepsis or just sepsis in general. (C interviewee)*

She continued to talk about her management of fever.

> *So me personally. I obviously complete the observations that I am doing. I ask some specific questions about how the patient is feeling. Whether or not they are showing signs of a focal point for their sepsis. You know, urinary sputum is a sample I might ask for at that time. I would go and take bloods and blood cultures if the bloods hadn't been done in the last few hours. And I would be looking at their chart to see what antibiotics they were on. (C interviewee)*

C, who worked in an oncology unit, would initially link fever with sepsis. She would then start to look for evidence of sepsis. Such testimony reflects how the clinical environment plays a crucial role in fever management.

Sepsis 6 guidelines and relating fever to infection

Additionally, the characteristics of the patients' underlying disease could be linked to the nurses' interpretation of their fever. Clearly, the nurses' interpretation of the fever would influence their management of the fever. Although different clinical settings presented different perspectives on fever, the interviewees all directly related fever with infection, especially sepsis. The following quotes by G and R offer cases in point.

> *It's usually that the high fever, the pyrexia is an indication that you've something way more serious going on here. Like sepsis or like a very adverse reaction to a drug. (G interviewee from psychology unit)*

> *Lots of patients are pyrexic because of their chest infection … lots of our patients are smokers. Before the operation they have COPD anyway, and then obviously being intubated is going to make that worse. (R interviewee)*

These extracts reveal how nurses connected fever with infection and sepsis. Therefore, they would rely heavily on Sepsis 6 guidelines. M expressed how Sepsis 6 became one of his main focuses when tackling fever.

> *I don't know. When I qualified as a nurse, probably, that was about the time when sepsis was gaining a high profile. I remember when I was a student nurse, being aware the changes in language around fever and the importance of sepsis. Sepsis was just becoming a much more, not just within nursing, but also within the wider public, as a thing. I think people were always aware of septic shock, that term, but never really knew what sepsis was or how prevalent it was. I remember just before I qualified, and then just after qualifying, that whole Sepsis 6 bundle rolled out. There was a lot of focus on meeting all the six criteria in the bundle, which are, if I can remember them all. I should because I do bank research. (M interviewee)*

The Sepsis 6 bundle had caught the attention of healthcare workers. Moreover, the clinical environment had enhanced M’s knowledge about sepsis through training. He continued his comments on the Sepsis 6 guidelines as follows.

> *Within an hour you should be giving paracetamol, you should be giving IV fluids. You should be giving IV antibiotics. You should be taking blood cultures. You should be doing a lactate and you should be monitoring urine output. I think that’s the six criteria. You were able to follow the, my patient has this, this, this. Needs this. And it would tell you the next thing to do. You need to escalate to a doctor or you need to these things. Yes. I don’t really think my management particularly has changed in the short time since I’ve been qualified because it was very much a high focused, high profile. (M interviewee)*

Given that training protocol, nurses would be aware of the Sepsis 6 guidelines straightaway when encountering fever and follow its steps to manage the fever. C, from the oncology background, mentioned that their clinical routine for managing fever very much depended on two of the sepsis guidelines.

> *… there is a neutropenic sepsis protocol … I’ve printed off. I have read it. I promise I’ve read it. But yes, I knew it before I printed it off. And that’s because of the way it became sort of a cultural approach to managing fever. (C interviewee)*
>
> *Yes it is. So it’s like the only protocol that you rely on? (Interviewer)*
>
> *Is it the only protocol that we rely on? …Obviously we’ve got the Sepsis 6 that’s underpinning it as well… . Yes but those two are probably the key ones for us. (C interviewee)*

The above quote indicates the importance of the guidelines in the eyes of the interviewees, and it suggests they would adhere to the protocols when managing fever. However, only about 50% of fevers are actually caused by infection (Toussaint et al., 2006; Ferguson, 2007; Ames et al., 2013; Ogawara et al., 2016). Around 10% to 15% of infections became sepsis (Toussaint et al., 2006; Carey, 2010; Jevon, 2010; Daniels et al., 2011; Chiu, 2012; Singer et al., 2016). Hence, over 50% of fevers are not related to sepsis. With their ingrained focus on sepsis, the participants tended to link fever directly to sepsis. These findings resonate with the previous discussion about misunderstanding guidelines. Although participants were aware of the guidelines relating to fever, they did not fully understand the proper utilisation of the protocol. As a result, both clinical experience and guidelines were potent in influencing the participants' responses to fever, especially in the decision-making process of managing fever. This indicates that their management of fever was rather intuitive. G offered his thoughts about the decision-making process.

> *Our patients come and go from the ward sometimes. So have they taken something when they've been out that's caused this physiological response? ... I think it's all intuitive things … I think you do it automatically. You know when you're assessing people. (G interviewee)*

M also spoke about the intuitiveness of the decision-making process.

> *I suppose, because when patients come into the emergency department and they are often much sicker, obviously, for a start. The process of dealing with somebody who is very sick, often very septic patients go straight into the resus room to be given fluids and to be assessed and all that kind of stuff, straightaway. It's almost like a processing line, people get packaged up and everything that needs to be done for them*

> *gets done. People are very practised at what happens. Often you'll get a crash call with a septic patient, or suspected sepsis, patient arriving in 10 minutes. You know you know that they're coming in and you're going to do those Sepsis 6 things straightaway. You've got people who are doing all that stuff. 'Obs', bloods and everything at once. (M interviewee)*

Both of the interviewees said they would make an intuitive judgement when managing fever. Again, the data suggest that such intuitiveness arises from the clinical environment and the customary approaches to managing fever there.

4.3.4.2 When to intervene in fever?

Question 34 asked participants the degree of temperature that they would start to treat fever. Despite asking the respondents to answer this question, not all respondents gave an answer. Many of the participants (n=82) would start to treat fever when the body temperature reached 38.0°C (see Table 4.). A total of 48 participants would begin to manage fever when the body temperature was in the range of 37.5°C to 37.9°C.

Temperature	**n**	**Percentage (%)**
37.5°C	14	7.91
37.6°C - 37.9°C	34	19.21
38°C	82	46.33
38.5°C	15	8.47

Table 4.35 Question 34. At what temperature do you personally begin to treat fever/hyperthermia?

At the same time, other factors would also be taken into consideration. Notably, the underlying disease or condition of the patient was one of the key factors in deciding on the fever management. The following statements by participants and interviewees mention other considerations.

> *Chronic renal failure patients tend to have a slightly lower body temperature therefore 37 degrees would be considered high. (Participant 4, questionnaire)*
>
> *39℃ in the surgery not had any treatment. (Participant 113, questionnaire)*

M and C made similar comments.

> *If somebody had a temperature over 37.6, and certainly in the 38s, then you would be thinking, ‘We need to deal with this.’ … I’m not saying that 37.6 is necessarily that’s a really bad thing that you need to deal with straightaway. Do you know what I mean? If somebody is normally at 36.8 and they’re creeping up by a whole degree, that’s not right … . You want to look at their trends and their chart and see because everyone is different. (M interviewee)*
>
> *So I suppose the management is mostly to do with that kind of, locating the source and looking for patterns in temperature. Sometimes people have temperatures at night, every night. I guess rather than jumping in to relieve symptoms of the temperature… . And some people will sit there with a temperature of nearly 39 and they won’t feel symptomatic … . They’ll know that they are warm but they are not distressed by it … . So we would ignore that with them, if you like. That might be something they’ve had every night for the last six months. (C interviewee)*

As these participant comments reveal, the condition of patients would impact the decision-making process. Both of the participants mention the trend or pattern in the patient's body temperature as one of the key observations in determining whether or not to intervene in the fever. The above comments also mention that participants would start to monitor for signs of fever before the actual fever point was reached. It is noteworthy, as well, that the patients' feelings about their fever were taken into account in the decision-making process. To summarise, the underlying disease and condition of patients were important in the participants' decision-making process.

Observations

Besides the underlying disease, other symptoms were observed in deciding whether or not to treat fever. The following quotes from participants indicate the sort of symptoms they would also to observe in a febrile patient.

> *We do that and obviously we assess their like the ABCs, like their airways, breathing, circulation, disability. We do all that as well too. And I think it's really hard to describe, because I think you do it automatically. You know when you're assessing people … . But I think the thing is, when we have unwell people. It's not just a temperature that's causing us concern. You know it's one element of. Or they are very sick. (G interviewee)*

Therefore, management of fever could be somewhat intuitive. While evaluating fever, G suggests assessing the airway and breathing, as well as taking the patients' condition into consideration before deciding whether or not to manage the fever. R states what kind of symptoms she would observe.

> *I guess you're trying to find infections. (Interviewer)*

> *A source, yes. If they were tachycardic and not expected to be… I think lots of the symptoms for fever and things our patients have for other reasons. Often the blood pressure is so low after the surgery, they’re on a lot of adrenalin and noradrenalin, if obviously affects their heart rate. That is because of the surgery rather than a fever. (R interviewee)*

Thus, other vital signs could also be key elements in the nurses’ observations. The data also reveal that participants would try to detect any signs of infection. A’s statement below underscores this approach.

> *Listening to their chest and things. If they have a crackly chest or when they’re coughing or I’m inducing a cough with suctioning, bringing up really dirty secretions. We send away samples and things. If I was redressing a wound and it looked infected, I would send away samples. Also, at the same time, if they had a high temperature I would be more worried. I would be observing their chest sounds and their winds and things like that. Also just feeling them. If they are peripherally really warm. If they are sweating and things. (A interviewee)*

Similarly, interviewee A says she would try to find signs of infection. She would also observe the overall appearance of the patients. C also offered her thoughts on making subjective observations.

> *But only really if the patient is symptomatic to the point of being quite unwell with it. So if they are rigoring or if they are distressed. So that is the point at which I would manage it. (C interviewee)*

Besides making subjective observations, C would also assess whether patients were suffering distress. Medications were also discussed in the interviews.

> *If the patient is having paracetamol and they still have 38 degrees … that's pretty awful. (R interviewee)*

> *But if you've got a patient on regular paracetamol who is still showing pyrexia then that's obviously going to be quite an achievement. (C interviewee)*

> *And I would be looking at their chart to see what antibiotics they were on. Because most of them are on antibiotics. And how long they have been on antibiotics for. And whether there are other sorts of. You know if they are on paracetamol or whatever. (C interviewee)*

As mentioned, the interviewees also considered the patients' medications as a factor in their assessment of the fever. A patient continuing to have a fever after using antipyretics was considered serious. The use of antibiotics would be assessed in considering the possible cause of fever. Accordingly, the use of antipyretics and antibiotics were also key elements for interviewees to monitor. Interestingly, while discussing those elements, none of the participants mentioned thoughts about the cause of fever.

4.3.4.3 Antipyretics

In order to understand what fever managements the participants would use, question 31 provided a list of fever interventions and participant could choose their preferred interventions on the list (see Appendix B). The top column of Table 4 demonstrated the fever interventions that were listed in the questionnaire. In question 31, participants were asked about their preference of fever managements. For example, some of the participants' first choice of fever management could be administrating paracetamol and providing a fan, while the other participants' first choice of fever management could be administrating aspirin. Therefore, the choice of fever management could be more than one intervention or just one intervention, depending on the participants' preference. The result of participants' first choice of antipyretics for patients with fever is displayed in Table 4. Fever is usually recurrent. Consequently, the questionnaire also asked if participant's first choice of fever management was provided and a patient's fever symptom still persisted, what would participants' second choice of fever management be. The result of participants' second choice of antipyretics for patients with fever was shown in Table . The result of participants' third, fourth, fifth and sixth choice of antipyretics for patients with fever were established in Table , Table 4., Table 4. and Table 4. respectively. In Table 4, Table , Table , Table 4., Table 4. and Table 4., the 'v' in each column indicated the intervention that was selected by the participants, while the number of 'n' in right hand side of the row represented the number of the people. For example, in Table 4, the second column showed that there were 2 participants chose tepid sponging as their first choice of fever management. In the same table, the fifth column indicated that there were 2 participants who chose fan and tepid sponging as their first choice of fever management. The very bottom column in Table 4, Table , Table , Table 4., Table 4. and Table 4. indicated the number of participants who chose the intervention in each row. For example, in Table 4, there were 146 participants choosing Paracetamol PO/Rectal as their first choice of fever management, while there were 19 participants choosing Paracetamol IV as their first choice of fever management. It was worth noting that the 'n' in the right row and the bottom column of Table 4, Table , Table , Table 4., Table 4. and Table 4. could added up to more or less than 177, due to the question was a multiple choice question and it was not compulsory to answer Question 31.

As to the general management of fever, 146 participants said that paracetamol (oral or rectal) was their first choice of antipyretic to manage patients' fever, while 80 of these participants would choose to use paracetamol alone (see Table 4). Table 4 shows that 39 participants would use paracetamol (oral or rectal) with a fan as their first choice of fever management. The second most popular intervention for the first choice of fever management was using a fan with 54 participants making this their first choice, however only 7 of these participants chose to use a fan alone. As for the second choice of antipyretic, 65 participants chose ibuprofen, with 48 choosing to use ibuprofen alone. While the second choice of intervention for 41 participants was the use of a fan, with 25 of them using a fan alone (see Table). For the third choice of antipyretic, 37 participants would use a fan, while 34 participants chose tepid sponging (see Table). More than 15% of the participants (n = 27) would use a fan alone and more than 14% of the participants (n = 26) would choose to use tepid sponging alone as a method to lower body temperature. As for the fourth choice of antipyretic, 21 participants chose a fan and 16 participants chose tepid sponging if the temperature of the patient was still not controlled (see Table 4.). Only 76 participants managed to complete answering the fifth choice of fever management (see Table 4.). The most popular strategy for the fifth choice was non-pharmacological antipyretics, including the use of a fan, a water-cooling blanket, an air-cooling blanket and tepid sponging. A total of 63 participants completed the question about their sixth choice of intervention to manage fever. Interestingly, about a quarter of those 63 participants would use intravenous cold fluid to reduce a patient's temperature (see Table 4.). The choice of intervention indicated that a participant usually started with pharmacological antipyretics when managing fever, but non-pharmacological antipyretics were selected for the third and subsequent choices. The use of intravenous cold fluid was one of the very last methods the participants would use to reduce body temperature, although it is noteworthy that this method was chosen at every level of choice for fever management. In fact, almost every method was chosen in every level of choice, including the use of an ice pack which was not a popular technique compared with other interventions.

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
										V		2	1.1
									V			3	1.7
								V				7	4
								V		V		2	1.1
								V	V			2	1.1
							V					1	0.6
						V						1	0.6
				V								1	0.6
			V									1	0.6
			V					V		V		1	0.6
	V											6	3.4
	V							V				2	1.1
	V	V										1	0.6
	V	V						V				1	0.6
V												80	45.2
V										V		7	4
V									V			3	1.7
V								V				18	10.2
V								V		V		7	4

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
V								V	V			6	3.4
V								V	V	V		3	1.7
V							V					1	0.6
V						V						1	0.6
V				V								1	0.6
V				V				V	V			1	0.6
V			V	V								1	0.6
V		V										5	2.8
V		V								V		1	0.6
V		V						V		V		1	0.6
V		V						V	V			1	0.6
V	V											6	3.4
V	V							V				1	0.6
V	V							V			V	1	0.6
V	V	V										1	0.6
146	19	11	3	4	0	2	2	54	19	24	1		

Table 4.36 Participants' first choice of antipyretics for patients with fever. v indicates the selected antipyretics method. [a] means n / 177 x 100.

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
												12	6.8
										V		12	6.8
									V			11	6.2
								V				25	14.1
								V		V		1	0.6
								V	V			1	0.6
						V						1	0.6
						V				V		1	0.6
						V		V				1	0.6
				V								2	1.1
				V						V		1	0.6
				V				V		V		1	0.6
				V			V					1	0.6
				V		V		V	V			1	0.6
			V									2	1.1
		V										48	27.1
		V									V	1	0.6
		V								V		2	1.1
		V							V			1	0.6

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
		V						V				2	1.1
		V						V	V			4	2.3
		V		V								1	0.6
		V		V				V				1	0.6
		V	V									2	1.1
		V	V	V					V	V		1	0.6
	V											14	7.9
	V									V		1	0.6
	V								V			1	0.6
	V							V				3	1.7
	V				V							1	0.6
	V				V		V				V	1	0.6
	V			V								2	1.1
	V	V										1	0.6
	V	V								V		1	0.6
V												10	5.6
V										V		1	0.6
V								V		V		1	0.6
V							V		V			1	0.6

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
V						V				V		1	0.6
V					V	V				V		1	0.6
V	V									V		1	0.6
16	26	65	5	11	3	6	3	41	21	26	2		

Table 4.37 Participants’ second choice of antipyretics for patients with fever. v indicates the selected antipyretics method. [a] means n / 177 x 100.

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
												39	22
											V	3	1.7
										V		26	14.7
									V			11	6.2
								V				27	15.3
								V		V		2	1.1
								V	V			2	1.1
							V					1	0.6
						V						4	2.3
						V	V	V	V			1	0.6
					V		V			V	V	1	0.6
					V	V	V					1	0.6
				V								7	4
				V						V		3	1.7
				V			V		V			1	0.6
				V		V		V				1	0.6
				V	V			V	V			1	0.6
			V									3	1.7
			V				V					1	0.6

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
		V										12	6.8
		V						V				2	1.1
		V				V						1	0.6
	V											12	6.8
	V										V	1	0.6
	V								V			1	0.6
	V					V						1	0.6
	V					V	V					1	0.6
	V		V			V						1	0.6
	V	V										1	0.6
V												7	4
V										V		1	0.6
V								V		V		1	0.6
9	18	16	5	13	3	11	7	37	17	34	5		

Table 4.38 Participants' third choice of antipyretics for patients with fever. v indicates the selected antipyretics method. [a] means n / 177 x 100.

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage (%)[a]
												81	45.8
											V	6	3.4
										V		13	7.3
									V			19	10.7
									V	V	V	1	0.6
								V				9	5.1
							V					1	0.6
						V						7	4
						V	V			V		1	0.6
					V							1	0.6
					V		V					1	0.6
					V	V						1	0.6
				V								7	4
				V				V				1	0.6
				V			V					1	0.6
				V			V			V	V	1	0.6

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage (%)[a]
				V	V							1	0.6
			V									1	0.6
			V		V				V			1	0.6
		V										7	4
		V								V		1	0.6
	V											9	5.1
	V						V	V		V		1	0.6
	V			V	V							1	0.6
V												3	1.7
V				V								1	0.6
4	11	8	2	13	6	9	6	11	21	18	8		

Table 4.39 Participants' fourth choice of antipyretics for patients with fever. v indicates the selected antipyretics method. [a] means n / 177 x 100.

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
												101	57.1
											V	3	1.7
										V		9	5.1
									V			9	5.1
									V	V		1	0.6
								V				5	2.8
							V					2	1.1
							V				V	1	0.6
						V						7	4.0
						V	V					1	0.6
					V							6	3.4
					V	V	V					2	1.1
				V								8	4.5
				V	V							1	0.6
			V									4	2.3
			V		V							1	0.6

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
		V										8	4.5
	V											5	2.8
	V								V			1	0.6
V												1	0.6
V		V									V	1	0.6
2	6	9	5	9	10	10	6	5	11	10	5		

Table 4.40 Participants' fifth choice of antipyretics for patients with fever. v indicates the selected antipyretics method. [a] means n / 177 x 100.

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)[a]
												114	64.4
											V	8	4.5
										V		7	4
									V			5	2.8
								V	V			1	0.6
							V					3	1.7
							V				V	1	0.6
						V						10	5.6
					V							5	2.8
					V	V	V				V	1	0.6
				V								6	3.4
			V									4	2.3
			V							V		1	0.6
			V		V	V	V				V	1	0.6
		V										2	1.1
		V	V								V	1	0.6

Paracetamol PO/Rectal	Paracetamol IV	Ibuprofen	Aspirin	Ice packs	Water cooling blanket	Air cooling blanket	Water pads	Fan in the room	Cool air/ air conditioner	Tepid sponging	Intravenous cold fluid	n	Percentage(%)^{a}
	V											2	1.1
	V				V						V	1	0.6
	V			V							V	1	0.6
	V		V									1	0.6
V												1	0.6
V	V		V		V	V	V				V	1	0.6
2	6	3	9	7	9	13	7	1	6	8	15		

Table 4.41 Participants' sixth choice of antipyretics for patients with fever. v indicates the selected antipyretics method. ^{a} means n / 177 x 100.

The correlation between the two most popular methods of fever management among the participants' first three choices and their responses to the questions relating to antipyretics (questions 20, 21, 22 and 24), was analysed using Pearson's chi-square test (see Table 4. and Appendix K). Participants who chose to use a fan as their third choice of fever management were more likely to answer question 22, about the side effect of external cooling, correctly (Value(1) = 7.288, $p = 0.007$), although this was not a strong association (phi = 0.203). Participants who chose to use a fan as their third choice of fever management were also more likely to answer question 24 correctly (Value (1) = 6.168, $p = 0.013$), but again the correlation between the question and the method to lower body temperature was weak (phi = 0.187).

The most popular intervention used to manage fever was pharmacological antipyretics such as paracetamol and ibuprofen. In the results from the questionnaire, the most popular medication for managing fever was paracetamol with ibuprofen the second most popular.

Question 32 asked about the frequency and dosage of antipyretics. The majority of participants recommended that patients with fever take 1 gram of paracetamol per dose, with a maximum daily intake of 4 grams of paracetamol. As for the frequency of the medication, most of the participants would give patients paracetamol four times a day if needed, with a slight variation of 4 to 6 hours between doses. A similar question regarding the correct dosage of paracetamol appeared in the knowledge part of the questionnaire (question 23, see Table 4). More than 80% of participants answered this question correctly. The overall understanding about paracetamol was quite accurate.

Q22, third choice-fan			third choice-fan		Pearson's chi-square test	
			0	1		
Q22	Wrong answer+ not sure	Count	91	15	Value	7.288
		Expected Count	83.8	22.2	df	1
	Correct answer	Count	49	22	Asymp. Sig. (2-sided)	*0.007
		Expected Count	56.2	14.8		
Nominal by Nominal			Phi		0.203	
Q24, third choice-fan			**third choice-fan**		**Pearson's chi-square test**	
			0	1		
Q24	Wrong answer+ not sure	Count	53	6	Value	6.168
		Expected Count	46.7	12.3	df	1
	Correct answer	Count	87	31	Asymp. Sig. (2-sided)	*0.013
		Expected Count	93.3	24.7		
Nominal by Nominal			Phi		0.187	

Table 4.42 Q22, Q24 and using fan as a third antipyretics choice cross tabulation. 0 indicates participants who did not choose the method of antipyretics, 1 indicates participants who chose the method of antipyretics, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability.

The following quote from G expresses his understanding of when to administer paracetamol.

> *Yes and a slightly elevated temperature, it probably would at that instance be appropriate to give them some paracetamol.*

> *Or certainly offer it to them. (G interviewee)*

Besides paracetamol and ibuprofen, some other methods of lowering body temperature were mentioned in the interview. As reflected in the questionnaire, the use of a fan and tepid sponging were the top two, non-pharmacological choices that nurses would use when managing fever. Below are some quotes on using a fan to manage fever.

> *Well generally as soon as somebody has got a temperature, I'll often put a fan on. (C interviewee)*

> *If they had 13 blankets on top of them, I would take off some of their blankets and maybe [use] a fan. You're lucky if you can get hold of a fan often. (M interviewee)*

As mentioned, another common technique for managing fever was taking the patient's clothes off or removing a blanket. It is interesting that taking layers off was often linked with tepid sponging for patients with fever. This is illustrated in the following quote.

> *That is my way; it's really just the tepid sponging and making sure that they are cooled down by removing clothes and things. As well as that, there's the paracetamol and ibuprofen—really that's it. (A interviewee)*

> *Whilst tepid sponging is not recommended, I would advise using a cool, damp cloth to wipe away sweat from face for comfort reasons occasionally. (Participant 39, questionnaire)*

> *But you know with your tepid sponging and you're taking some layers off because they quite often want to be more layered up. (C interviewee)*

> *As well, we often have fans around the patient and give a cold bed bath if they're uncomfortable with a high temperature. (R interviewee)*

These statements indicate that the use of tepid sponging was often combined with other physical antipyretics such as fans and removing clothes. Occasionally, however, participants would combine the tepid sponging with pharmacological antipyretics. It is noteworthy that some participants performed tepid sponging for comfort reasons. Nevertheless, according to the NICE guidelines, tepid sponging has not been recommended as a method to reduce body temperature for a decade. The reason for this is that tepid sponging could cause vasoconstriction and result in a further rise in the patient’s temperature. Moreover, the process of tepid sponging or cold bathing could cause febrile patients to shiver, potentially increasing metabolic rate (Jevon, 2010; Dai and Lu, 2012; Doyle and Schortgen, 2016; NICE, 2017). Less than 45% of the participants answered the question about the side effects of using physical cooling correctly (question 22, see Table 4). Apparently, this knowledge had not yet been communicated to nurses in general. Besides tepid sponging, other physical antipyretics were noted including the use of cold drinks.

> *I’d also encourage them to like, drink some cold drinks. Drink fluids and stuff like that. (G interviewee)*

Although giving a cold drink was not one of the managements listed in the questionnaire, it seemed to be in general use as a method to reduce body temperature. Also, the theme of antibiotics was picked up in the interviews. Unexpectedly, interviewees said they regarded antibiotics as one of the interventions used to manage fever. The following is a quote from interviewee C, when talking about interventions to manage fever.

> *… but obviously antibiotics are assisting in there as well. (C interviewee)*

Although few participants considered antibiotics to be a direct intervention to reduce body temperature, most of them linked fever with infection and knew that, by controlling infection, antibiotics are effective in managing fever.

> *… Fever is managed once patient has been assessed and antipyretics are usually accompanied by IV antibiotics as per policy. (Participant 40, questionnaire)*

> *… which I normally treat with antibiotics … paracetamol and ibuprofen. There used to be a lot more antibiotics given out for fevers and things like that. (A interviewee)*

Moreover, the use of antibiotics is also strongly associated with the Sepsis Six bundle.

> *Following the Surviving Sepsis Campaign and national roll-out of the Sepsis Six, there is greater emphasis on sepsis as a syndrome, than of fever as a numerical marker of illness. In considering the available evidence for administration of antipyretics in sepsis, I always consider these as second-line therapies as there is much better evidence for the association of administering antibiotics and fluids with improving morbidity and mortality - whereas lowering temperature helps relieve the distressing effects of pyrexia and makes the patient generally feel 'better'. (Participant 14, questionnaire)*

> *Within an hour you should be giving paracetamol, you should be giving IV fluids. You should be giving IV antibiotics. You should be taking blood cultures. You should be doing a lactate and you should be monitoring urine output. I think that's the six criteria. (M interviewee)*

The nurses advised prescribing antibiotics because they often associated fever with infection. For that reason, antibiotics were recommended to resolve the potential underlying disease. Another common management that would be provided during fever was giving fluids. Dehydration was one of the main concerns with a pyretic patient, because it could lead to low blood pressure. Hence, interviewees would provide fluids for patients with fever.

I would also get them to drink lots of fluids and the usual things like that. (A interviewee)

Whether or not you require like your IV fluids. (C interviewee)

… remove or loosen clothes, offer water to drink. Oxygen if hypoxic, IV fluids, blood cultures, IV antibiotics, lactate, consider catheter, reassess frequently. (Participant 29, questionnaire)

IV fluid is an important point of management not just for cooling, but rather to compensate for the dehydration effects of, as a result of the fever. (Participant 34, questionnaire)

The above comment reveals that increasing fluid intake was considered essential for fever patients. Clearly, pharmacological antipyretics were popular in fever management; however, physical antipyretics were often performed and fluids provided as well. It is surprising that antibiotics were considered to be a part of antipyretics, as antibiotics were used to treat infection and could not directly reduce a patient's fever.

4.3.4.4 The rationale of managing fever

The reasons for nurses to commence managing fever were also discussed in the interviews. The results indicate that participants were concerned about the side effects of fever such as brain damage, febrile convulsions and patient discomfort.

Just so that the temperature doesn't go too high and they end up with a fever. I know that it's the body's response but, at the same token, if it gets too high, they end up with certain things like convulsions or things like that. I tend to try to keep the temperatures down because of that. (A interviewee)

In this comment, A expresses worries about the adverse effects of fever. She then continues with a more serious scenario.

> *It can cause kidney damage and things like that, so we're trying to avoid major organ shutdowns. (A interviewee)*

This extreme fever scenario sounds more like a sepsis situation. Interviewee G also shared his reasons for managing fever.

> *It's usually that the high fever, the pyrexia is an indication that you've something way more serious going on here. Like sepsis or like a very adverse reaction to a drug … . You know people can die in delay from sepsis and from things like neuroleptic syndrome and stuff like that … . I suppose if someone has a high temperature you are just quite concerned about them. You are wondering what's going on, like why. Because I think they're just at risk of deteriorating. (G interviewee)*

G also expressed worries about fever. The comments reveal that, from the participants' point of view, fever represents infection and sepsis and could eventually lead to death. The statements also reveal that participants were concerned that fever patients could suffer from febrile convulsions. It was noted that the side effects of fever were considered to be possible worst case scenarios. These worries suggest that the participants did not have enough knowledge about the disadvantages of fever. This is supported by the results of question 27 in the questionnaire. Question 27 concerned the dangers of fever. Only 23.7% of participants chose the right answer, which was dehydration (Table 4). About 45% of the participants chose febrile convulsions as the answer to this question, and about 27% of participants chose brain damage as the primary danger of fever. However, not all participants were anxious about the side effects of fever. Take participants 31 and 16 for example.

> *… The use of antipyretics will not prevent febrile convulsions; a large majority of nurses in my experience are very fever phobic. (Participant 31, questionnaire)*

> *The sepsis protocol is essential and really good but can reinforce 'fever fear'. (Participant 16, questionnaire)*

Participant 31 clearly had good knowledge about antipyretics. It is interesting that the terms '*fever phobic*' and *'fever fear'* were mentioned in the participants' comments. The qualitative data indicated that the nurses were fever phobic. Although the side effects of fever, including sepsis, were exaggerated, it was surprising to notice that the benefits of fever were very rarely mentioned in the interviews. This matched the findings from the questionnaire. Only 23.16% participants answered question 26 correctly, which concerned the benefits of fever (see Table 4), while 48% of the participants indicated they were not sure about this question.

Besides the side effects of fever, discomfort was one of the major reasons that prompted the participants to manage fever. Interviewees expressed their opinions about promoting comfort.

> *… if you give them the paracetamol, sometimes it works really well and they feel more comfortable. (R interviewee)*

> *It's when they are lying there and not doing anything that it's time to start worrying, especially with kids. I would just use something and I would automatically go for something because I don't want that temperature to soar. (A interviewee)*

> *While not wanting to suppress antibody production analgesics such as paracetamol may be given to promote comfort. (Participant 38, questionnaire)*

These comments reveal that the patient's experience of fever was deemed crucial by the interviewees in prompting them to manage the fever. Since a patient could feel discomfort during fever, they could also ask for antipyretics or methods to lower body temperature. G explained the situation.

> *And you find a lot of the time our patients will come and ask for it … 'Oh I have a cold',' I have flu', 'I'm not feeling great', 'I think I need some paracetamol'. You know. (G interviewee)*

As a result, side effects and patient experience played important roles in the decision-making process of fever management. When these factors were taken into account, participants would feel more confident when taking a step forward to reduce fever. A and M expressed their thoughts about administering paracetamol.

> *I wouldn't do anything until the temperature goes up. I just keep them cool. (A interviewee)*

> *'Right. When is your next paracetamol due? Are you due paracetamol?' I would give that paracetamol, ibuprofen or whatever, an antipyretic first of all and go, 'Right, I'll come back and assess you in half an hour and see how you are then.' Maybe your temperature has come down, and that probably means that we're okay. (M interviewee)*

Accordingly, preventing pyrexia was a popular consideration for managing body temperature. As M stated above, antipyretics would be provided as soon as the fever was identified. M offered further thoughts about the rationale for managing fever.

> *From the very basic, one of the very first things that you learn when you're training is that these are the normal temperature ranges that you're looking for. If a patient is over that or below that, then immediately, that's knocking the homeostasis out of balance and that's not a good thing because you want to maintain that balance .... Yes. You want to maintain the proper*

temperature. (M interviewee)

M here expressed an eagerness to maintain the body temperature in the normal range. Antipyretics, consequently, were his initial consideration when encountering a fever situation. Eventually, this eagerness was connected with an intuitive response to administer antipyretics to patients with fever. This decision-making process would become increasingly automatic. Participants further explained their decision-making process in the interviews and on the questionnaire.

> *That you start making decisions when you're trying to think and a judgment about what is causing this. What is the root cause of this? (G interviewee)*

> *In a surgical ward, fever is considered a major indicator of sepsis and national protocol indicates for its timely management - however clinical judgement also is needed, as a fever in an elderly person may present differently to a younger person due to the variations of core body temperature in the life span. We were taught to consider the pattern of temperature change along with the holistic clinical history and condition of the patient. (Participant 19, questionnaire)*

> *It's almost like a processing line, people get packaged up and everything that needs to be done for them gets done. People are very practiced at what happens. (M interviewee)*

The above quotations reveal that although the decision-making process of fever was rather intuitive, complications in the patient's condition would also force participants to pause and reflect. This deliberation process would draw on the nurse's experience and knowledge, and on the guidelines. These key factors in the decision-making process of fever management formed a nurse's independent professional judgement. G expressed his thoughts about the decision-making process as follows.

> *But actually when it does happen, I think you automatically kick in. Your mind automatically kicks into, right crisis mode. This is what we need to do. Da, da, da, da, da … and you’re doing the very kind of. You do it in a very systematic way. You do it without thinking. (G interviewee)*

This statement illustrates that the decision-making process could be either intuitive or systematic depending on the situation, which resonates with the dual process decision- making theory as described in Chapter 1 (Croskerry, 2005; Croskerry, 2009). Decision-making theory is discussed in more detail in the next chapter.

4.3.4.5 Identifying the gap between the evidence and clinical practice

Unfortunately, the present study notes a clear gap between the latest scientific evidence and clinical practice. It was questioned whether the participants were aware of the updated information and could identify the gap between the evidence and their knowledge. The following quotations display some of the participants’ views about managing fever.

> *I know that there is literature around the fact that when patients have a temperature, that’s actually quite a good thing because it’s dealing with the infection that’s going on. Having a temperature can cause the body to produce more leucocytes and to be able to help deal with the infection. By taking the temperature down, you are stopping that automatic response the body has to go, ‘There’s something not right here, do this to make it better.’ The body has got its own … I suppose it is doing it together really helping. (M interviewee)*

> *There is debate as to whether to symptomatically treat a rigor by adding extra blankets for patient comfort. Or to remove*

> *blankets and/or apply external cooling which would possibly prolong rigor and patient discomfort. (Participant 32, questionnaire)*

The participants demonstrated an awareness of the disadvantages of managing fever. However, the participants also affirmed that in clinical practice, clinicians instinctively tended to intervene to control body temperature. Accordingly, one of the participants expressed her priority when managing fever.

> *I do feel that antipyretics act as firefighting and the root cause of the infection needs to be identified and treated when possible by blood cultures. (Participants 38, questionnaire)*

In observing the fever patient, the participants would try to identify the cause of fever. Although the latest guidelines suggest investigating the cause of the fever as part of its management (Bridgwater et al., 2015; NICE, 2017), the result of this study showed that the current clinical practice nurses to quickly assume that the fever was caused by infection. Moreover, often without actually confirming the cause of fever, antipyretics would be performed by nurses. One of the participants expressed his feeling about this form of early intervention in fever.

> *I think that we intervene too quickly in the hospital environment. (Participant 15, questionnaire)*

The findings of this study indicate a clear gap between current practice and the latest scientific evidence about fever. Moreover, misunderstanding the guidelines, poor fever knowledge, and fever phobia widen the gap between the recommended practice and current fever management in clinical practice even farther. Accordingly, in the study participants expressed their uncertainty

When talking about the management of fever, the following statements show the participants' concerns about their lack of fever knowledge.

> *I feel confused … . I feel uncomfortable with the lack of clarity surrounding this issue. (Participant 12, when talking about the immune response of fever, questionnaire)*

> *I still think there is poor understanding that a 'Fever' is not necessarily a bad sign and that it is a natural process. (Participant 16, questionnaire)*

Unexpectedly, worries about their lack of fever knowledge was one of the main reasons that participants decided to take part in the interviews. The following two quotations indicate the interviewees' motivation for participating.

> *It was the fever side that I was interested in. I was actually interested in whether there was any difference from what I would do and whether I would be on the right track if someone had a fever. … I wasn't 100% sure that my care was the same as everybody else's. (A interviewee)*

> *Yes, actually I think they pretty much would do the same as I would do. And I hope that I am doing the right thing. (C interviewee)*

Lack of critical thinking

Although gaps between the latest scientific evidence and fever management were identified, this did not seem to have an impact on the nurses' management of the fever. The findings show that participants were aware of the differences between their knowledge and their current management approach as indicated by R's comments below.

> *I remember asking a colleague once. Somebody had a fever and they were like, 'Okay. Give them paracetamol.' I said, 'Won't that mask the symptoms?' They said, 'Yes. But they're*

> *going to be really uncomfortable. The fever is going to make them feel really uncomfortable, so you should make them feel comfortable by giving them paracetamol.' (R interview)*

Similar scenarios were noted in the qualitative data. The study results show that awareness of the gap between participant knowledge about fever management and the guidelines would not tend to change their current practice in response to fever. 'Lack of critical thinking' was one of the themes that became evident in the analysis. This phenomenon was discovered to be the key to understanding the gap between knowledge and clinical practice. Because of a lack of critical thinking among the participants, they did not confirm the gap to themselves existentially, thus, they took no action to bridge the gap between clinical evidence and their management of fever. This was illustrated by C in the following discussion.

> *Obviously the lasting memory was the bit that I really didn't know the answers to … . (C interviewee)*
>
> *So you are talking about. You think that you're actually quite confident with what you do dealing with fever when you are on your shift, but when you look back on the questionnaire you feel like maybe you lack some of the knowledge? (Interviewer)*
>
> *Yes, horrified. Yes … . Even in my current post. I haven't felt the need to go and look it up … . Yes, never even questioned it. (C interviewee)*

Interviewee C also expressed their reason for not questioning their practice.

> *So why do you think you never discuss like, the pathology behind it? (Interviewer)*
>
> *I suppose because it's not directly relevant to management. (C interviewee)*

Apparently, it was difficult for participants to link the indirect, objective information about fever with their practical, hands on, fever management. The findings of the study reveal that the participants did not take the step of integrating the updated knowledge about fever with their practical approach to fever management unless they felt it was directly relevant. Moreover, they did not think deeply about the rationale of fever management, as indicated by M in the following statement.

> *The participant felt that he never thought about the rationale behind the 'usual' administered managements. It was after his role as a research nurse and the completion of the fever questionnaire, he thought carefully about whether the usual managements were evidence based or not. (Notes approved by M interviewee)*

In addition, their intuitive, or common-sense approach, in fever management could have a negative impact on the possibility and traction of critical thinking.

> *As he mentioned, there were often a lot of things that nurses did without understanding completely about reasons of doing it. Usually, those managements were considered as common sense. (Notes approved by M interviewee)*

The comfort of their intuitive, common-sense approach seemed to stop participants from thinking. There were also occasions when participants did not have enough confidence even to think critically. An interview with R revealed the following.

> *As you say, if someone is on paracetamol, it's going to mask it and things like that. I remember asking a colleague once. Somebody had a fever and they were like, 'Okay. Give them paracetamol.' I said, 'Won't that mask the symptoms?' They said, 'Yes. But they're going to be really uncomfortable. The*

fever is going to make them feel really uncomfortable, so you should make them feel comfortable by giving them paracetamol.' …… Yes. But then I think, is it just because of my experience? I've not had much experience, so I don't … . (R interviewee)

I guess you also doubt yourself as to whether you have enough experience or knowledge? (Interviewer)

Yes, I think so. (R interviewee)

Evidently, participant confidence would not only have an impact on their motivation to acquire new knowledge of fever, but it also would reduce the prospect of their thinking critically about their day-to-day clinical practice.

4.4 Factors relating to fever knowledge and fever management

4.4.1 Factors relating to fever knowledge

Several factors were found to be associated with knowledge about fever, one of which was the education. Although the highest educational level of the respondents had no significant association to the total knowledge score (see Section 5.3.2.1), education was mentioned several times during the interviews. All the participants believed that education played a key role in their knowledge of fever. It would seem that nursing education helped participants to generate their knowledge about fever.

M explained that their knowledge about fever originated from their education.

A lot of these things you do cover when you're in your nursing training. (M interviewee)

G made a similar comment.

> *I think it comes from our educational background. Because I think, like, there's more pushing us doing more training …. (G interviewee)*

Nursing training formed the basis of the participants' knowledge of fever. It was also noted that clinical experience enhanced the participants' knowledge of fever gained during their training. Interviewees R and G explained this in detail.

> *I think the knowledge was provided. Thinking about that in a classroom is so much different than thinking about it on a busy ward. You just forget things. … Looking back at my old physiology notes from my training, this all makes sense … . It feels like my specific knowledge like that has decreased a bit, but practically applying the knowledge is maybe a bit better … . (R interviewee)*

> *… which is all scenario learning. So when it does happen in real life, you know, you kind of automatically start … [the decision making process] … . I think it comes from our educational background ... . (G interviewee)*

Interestingly, a finding in the analysis of the questionnaires showed a comparable result. There was a statistically significant positive association between the number and variety of units at which the participants had studied, and their total knowledge score (p=0.012, see Section 4.3.2.1). The results from both the interviews and questionnaires confirmed that having applied knowledge in a practical situation helped nurses to recall knowledge at a later time.

Confidence was another element that had a huge impact on generating fever knowledge. 'Confidence about fever knowledge' was one of the themes identified in the results of the qualitative data. Although the results indicated that there was a concern about the lack of overall knowledge of fever, most of the participants, surprisingly, were confident about their knowledge of fever before beginning the questionnaire. Interviewee A expressed confidence in her fever knowledge, especially when managing it.

> *I am trained pretty highly, actually … I have never really come across anything where I have thought, ‘No—‘. (A interviewee)*

As indicated by this comment, A was confident about herself, she had never doubted her management. It was found that confidence had a negative correlation with knowledge about fever, and the more confident a person felt, the less motivated they were to update their knowledge of fever. Interviewee C illustrated the relationship between confidence and knowledge of fever in the following extract.

> *I haven’t felt the need to go and look it [knowledge about fever] up. (C interviewee)*

The questionnaire suggested the same. More than 80% of the participants believed that controlling fever could reduce a patient’s hospital stay as well as mortality rates (see Section 4.3.3). The results revealed that participants were confident about their thoughts in how to manage fever. Less than 10% of participants selected ‘not sure’ for questions 28 and 29 on this subject. Analysis using the Mann-Whitney U test showed a significant association (U=1459.0, p=0.012) between participants’ thoughts that controlling fever reduced a patient’s hospital stay and a lower total knowledge score. This indicates that participants who believed that controlling fever was beneficial, had a lower total knowledge score, compared with participants who thought that controlling fever might not decrease patients’ hospital stays. No evidence to date has demonstrated that reducing fever decreases hospital stay or mortality rate. In fact, some articles suggest the opposite, that managing fever results in an increase in the length of a patient’s hospital stay or their mortality rate (Carey, 2010; Eyers et al., 2010; Holtzclaw, 2013).

Unexpectedly, although participants were confident about their fever knowledge, many stated that their reason for participating in the interview sessions was because they wanted to learn more about fever. Take the quote below as an example.

> *It was the fever side that I was interested in. I was actually interested in whether there was any difference from what I would do and whether I would be on the right tracks if someone has a fever. More than anything, I was wondering if there is something different that they would do now. (A interviewee)*

Interviewee A spoke of her worries about her lack of knowledge about fever. Other interviewees also stated the same disquiet about their lack of knowledge.

> *It highlighted to me that I actually have no idea what the, you know, the physiology of the fever. And that I probably should go and have a look… . And realise [after the questionnaire] that my lack of knowledge was: yes. Completely. (C interviewee)*

It seemed that C not only had concerns about her lack of knowledge, she was not expecting that she would be required to enhance her knowledge of fever. Another similar example was provided by M.

> *I remember finishing the questionnaire and thinking 'I feel like I really don't know the things that I should know'. (M interviewee)*

It was found that a lack of confidence in knowledge about fever made the participants more willing to take part in the interview and increased their motivation to learn more. As a result, misplaced confidence could be identified as a potential obstacle to seeking to acquire or update fever knowledge.

In addition, the Sepsis Six bundle (see Section 1.4.4) also had a crucial impact on knowledge about fever. The emphasis on the Sepsis Six bundle explained the reason for its importance in generating knowledge of fever. Take the excerpts provided by M and participant 14 which were mentioned before as examples.

> *When I qualified as a nurse, probably, that was about the time when sepsis was gaining a high profile. I remember when I was a student nurse, being aware of the changes in language around fever and the importance of sepsis. (M interviewee)*

> *Following the Surviving Sepsis Campaign and national roll-out of the Sepsis Six, there is greater emphasis on sepsis as a syndrome, than of fever as a numerical marker of illness. (Participant 14, questionnaire)*

It appeared that the successful campaign for the Sepsis Six bundle embedded it in the minds of the participants. Nowadays, however, knowledge about fever is changing rapidly. Participants expressed their concerns about the new information.

> *These things change over the years as well. What we think is a way to manage something when we finished our nursing training, 10 years later it is totally out of date. (M interviewee)*

> *There used to be a lot more antibiotics given out for fevers and things like that, which does not happen now, because we have learned since then. There have been a lot of changes in 45 years .... (A interviewee)*

As mentioned previously, in such rapidly changing times, nursing care depends largely on evidence-based research. The lack of access to new information about fever makes it difficult to generate knowledge about it.

Interviewee A expressed her concerns about finding a course where they could learn more about fever.

> *Personally, I've never come across one about fever. (A interviewee)*

Therefore, lack of access towards new fever knowledge was one of the factors inhibiting the ability to update knowledge about fever.

Figure 4.11 sums up the factors that influence knowledge production in fever. The width of the arrows indicates the intensity of the association. For example, Access to new knowledge had the least impact on knowledge about fever. This figure demonstrates that lack of confidence had a positive association with fever knowledge, while access to new knowledge also had a positive association with less influence on generating fever knowledge. However, lack of access to new knowledge was found in this study. As a result, it had negative impact on generation fever knowledge. Education also played an important role while building up fever knowledge. Moreover, practical experience can enhance the fever knowledge generated from nursing education. Another important factor that had contributed to participants' fever knowledge was the Sepsis Six bundle.

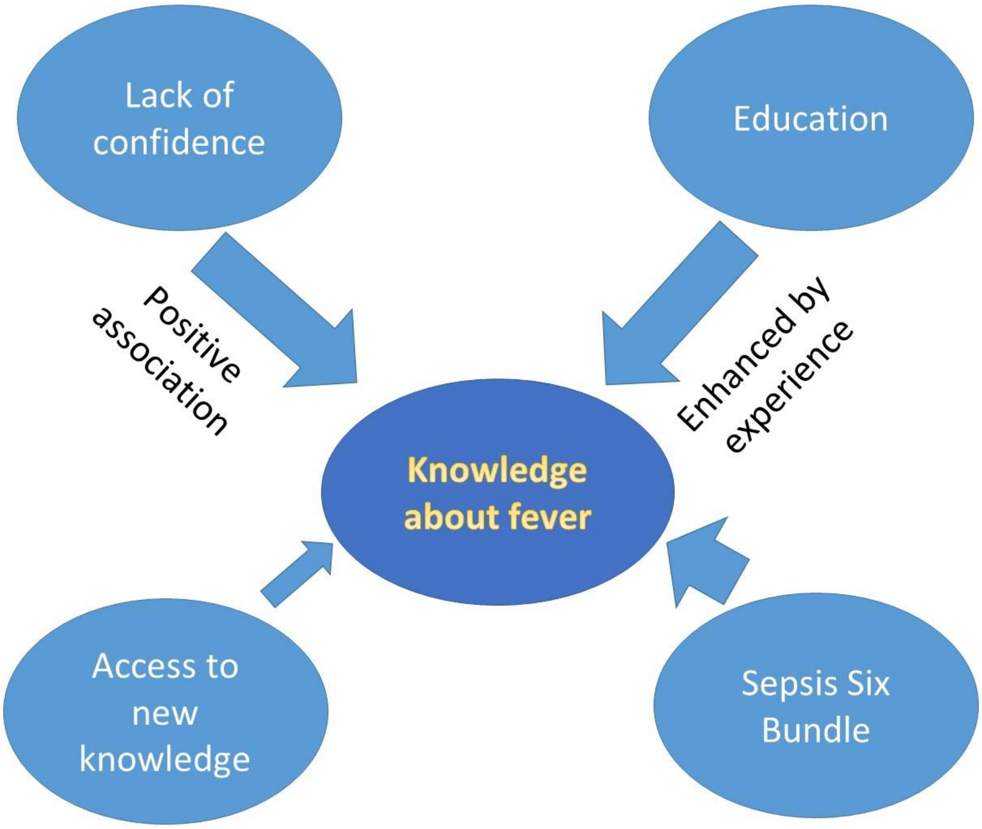

Figure 4.11 Factors influencing the generation of knowledge about fever. The width of the arrows indicates the intensity of the association.

4.4.2 Influences from knowledge about fever

This section will discuss different factors that were influenced by knowledge about fever. The scores from the questionnaires about fever knowledge demonstrated that there was a concern about insufficient fever knowledge. The mean score in the fever knowledge section for all participants was just 0.96, with more than 50% of the participants scoring zero or below zero (see Section 4.3.2.2). The analysis of the results from both the questionnaires and the interviews showed there were four aspects of fever management that participants appeared confused about. These were the definition of fever, the purpose of fever, the use of antipyretics and the benefits of fever.

In the results from the questionnaire, the question with the lowest mean score (-0.68) was question 18, which was about the definition of fever. Accordingly, another question related to the definition of fever was question 19. The question with the third lowest mean score (-0.24) was question 19, which was about the temperature at which brain damage might occur. It was clear that the definition of fever was one of the areas where the participants were uncertain. Participants also scored badly on questions 11 to 13, which related to the purpose of fever. Question 11, with a mean score of -0.12, concerned the possible factors that might contribute to pyrexia, while question 12, with a mean score of -0.05, was about the basic mechanism of fever, indicating that the majority of participants answered the question wrongly. Although the mean score for question 13, which was about the aetiology of fever, was 0.11, 43.5% of participants thought that only infectious diseases contributed to fever (Appendix I). The qualitative findings were identical to the quantitative findings. The results of the qualitative data suggest that the participants believed that fever was directly related to infection. Take the quotation from A as an example.

> *It's the body's reaction to infection or bacteria of some kind, or viral. I can't think of anything else that would bring that [fever] on. (A interviewee)*

Among the 177 participants, only two of them mentioned the correct evidence about the purpose or cause of fever. The extracts from participant 13's questionnaire and M's interview demonstrated their understanding about the basic mechanism of fever:

> *I was under the impression that it was the body's response to kill the infection and if we took the temp down the infection could last longer. (Participant 13, questionnaire)*

> *I know that there is literature around the fact that when patients have a temperature, that's actually quite a good thing because it's dealing with the infection that's going on. Having*

a temperature can cause the body to produce more leucocytes and to be able to help deal with the infection. By taking the temperature down, you are stopping that automatic response the body has to go … . (M interviewee)

From the results of the questionnaires and interviews, it was evident that there was widespread concern about the lack of knowledge of the purpose of fever. The above quotations also show that participants were aware of the benefits of fever. However, more than 60% of participants answered question 25, which was about the basic benefits of fever, correctly. However, in response to question 26, a more specific question about the benefits of fever, 48.02% of the participants answered 'not sure' (see Appendix I). The analysis found a significant association between the answers to questions 25 and 26 (see Section 4.3.2.2), indicating that participants who answered question 26 correctly were more likely to have also answered question 25 correctly, although there were only 19.2% of participants (N = 34) who answered both questions correctly. These results indicate that most of the participants had only basic knowledge about the benefits of fever and among the 177 participants, only two had better knowledge about the likely benefits of fever. It is suggested that even though participants knew about the basic benefits of fever, they tended to forget them when completing the questionnaire. The results for the questions about for the disadvantages of fever were also poor. The mean score for question 27, about the primary danger of fever, was -0.49, this was the second-lowest score on the questionnaire. Although the primary danger of fever is dehydration, more than 45% of the participants gave febrile convulsions as their primary concern (Section 4.3.2.2). Interviewee A illustrated her understanding about the side-effects of fever in the following comment.

… by the same token, if it gets too high, they end up with certain things like convulsions or things like that … . It can cause kidney damage and things like that, so we're trying to

> *avoid major organ shutdowns. (A interviewee)*

It seemed that A believed that pyrexia could be very harmful. G made similar comments.

> *It's usually that the high fever, the pyrexia is an indication that you've something way more serious going on here. Like sepsis or like a very adverse reaction to a drug. (G interviewee)*

> *I suppose if someone has a high temperature you are just quite concerned about them. You are wondering what's going on. Like why. Because I think they're just at risk of deteriorating. (G interviewee)*

G's comments indicate that sepsis, an adverse reaction to a drug and deterioration are his main concerns for a febrile patient. By looking at the sections on the benefits and disadvantages of fever in both the qualitative and quantitative data, it was concluded that participants had poor understanding of the benefits of fever because they were either not aware of them or had neglected this area of knowledge. In addition, participants were confused about the side effects of fever. It was obvious that the disadvantages of fever were over emphasised by most of the participants causing what is known as 'fever phobia' as mentioned by participant 31.

> *… a large majority of nurses in my experience are very fever phobic. (Participant 31, questionnaire)*

It seemed that because of misunderstandings about the benefits and disadvantages of fever, most of the participants were 'afraid' of it. As a result, participants would try to reduce a fever every time they encountered it. Consequently, the use antipyretics became popular since fever was commonly observed in the clinical environment. Nevertheless, the lack of knowledge in the use of antipyretics was one of the issues highlighted in the findings as illustrated by interviewee A's comment below.

> *I think that I would treat all fevers with paracetamol, ibuprofen and so on, taking off as many clothes as possible, those sorts of things. (A interviewee)*

Pharmacological antipyretics were once deemed to be 'wonder drugs' when treating fever, because it was effective to subside the fever symptom. Although there was not yet any published evidence to show there would be more benefit to patients by reducing fever, this study suggested that both pharmacological and physical antipyretics are commonly used in the clinical environment. The results from the questionnaire showed that although participants' understanding about the dosage of pharmacological antipyretics was sufficient, the side effects of external cooling techniques were not fully understood. Question 22, which concerned the side effects of physical cooling, had a mean score of -0.11 (see Section 4.3.2.2) as only 40.1% of participants answered correctly. Surprisingly, 8.5% of participants were 'not sure' of the answer. The findings of the questionnaire suggested that participants might not have enough knowledge about the benefits and disadvantages of antipyretics.

Perhaps because the participants lacked any depth of knowledge about fever, when managing a febrile patient, they would relate the cause of the fever to a cause that they had encountered previously, such as an infection. Interviewee G suggests infection can cause fever in the quote below.

> *Obviously I know like, if someone has a high temperature, it can cause lots of complications. It's not a good or it's a sign of infection. (G interviewee)*

Along with infection, disadvantages of fever were also mentioned in the above quotation. It seems that the participants' knowledge of fever has a considerable influence on their initial interpretations about fever. The initial interpretation about fever in this thesis meant the first thoughts on the cause of fever when the participants observed fever. For example, a participant's initial interpretation might be to link the fever with an infection.

In conclusion, the results showed concerns about the lack of knowledge about fever, especially in the four areas mentioned in this section, namely the definition of fever, the purpose of fever, the use of antipyretics and the benefits of fever. It is worth noting that, in relation to the purpose of fever, participants showed misunderstandings about the causes and basic mechanisms of fever. There was also a lack of knowledge about the use of some antipyretics, for example participants were uncertain about the side effects of physical cooling, and they did not fully understand the rationale for administering paracetamol. When it came to the benefits and disadvantages of fever, it appeared that participants had limited knowledge about its benefits and tended to exaggerate its disadvantages, leading to an overall fear of its presence. It was clear that the participants’ overall knowledge of fever had a particular impact on their initial interpretations about fever. Figure 4.12 sums up the impacts that are influenced by knowledge of fever.

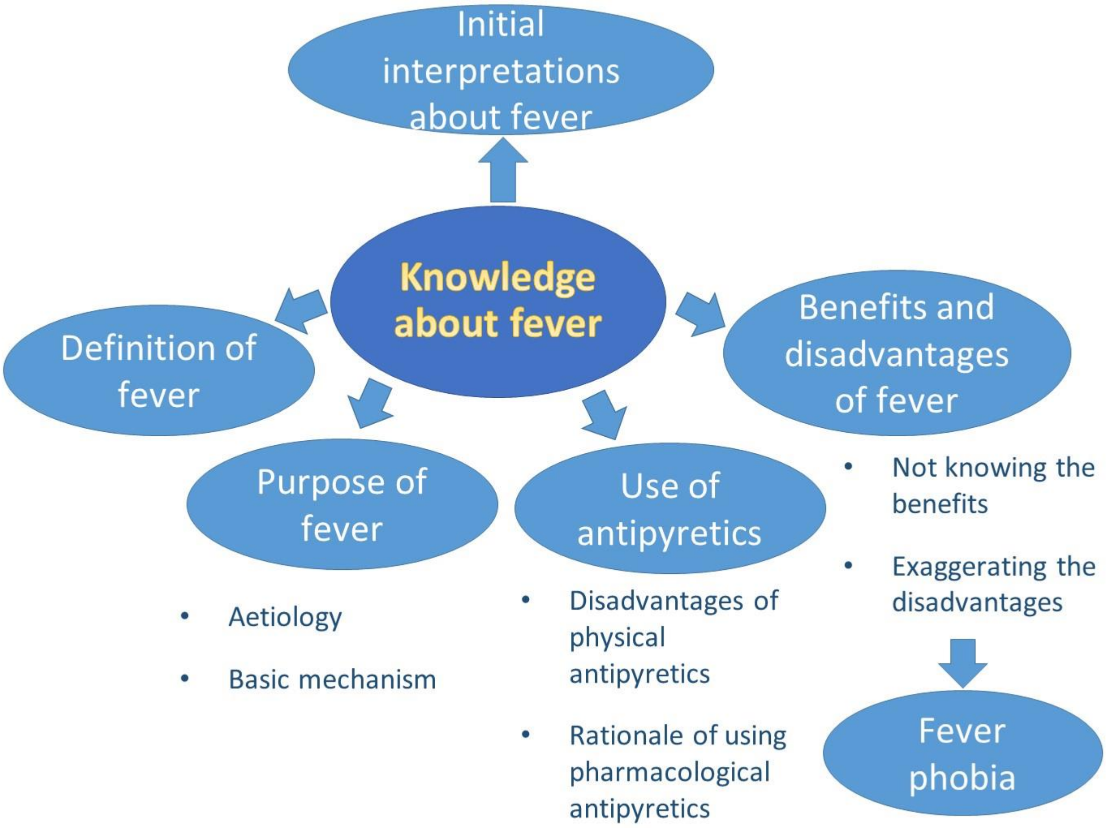

Figure 4.12 Influences caused by knowledge about fever.

4.4.3 The Sepsis Six bundle

Severe sepsis is estimated to use up to 50% of critical-care resources (Daniels et al., 2011). With the sepsis syndrome gaining a high profile, the Sepsis Six bundle was widely adopted in the UK. As previously discussed (see Section 1.4.4), the promotion of the Sepsis Six bundle not only influenced the generation of knowledge about fever, but it also led to some nurses becoming fever phobic.

> *The sepsis protocol is essential and really good but can reinforce 'fever fear'. (Participant 16, questionnaire)*

It seems that nurses were initially afraid of fever, and the subsequent fear of sepsis reinforced their concerns. Take this extract from Interviewee G as an example.

> *You know people can die in delay from sepsis and from things like neuroleptic syndrome and stuff like that. (G interviewee)*

The bundle not only highlighted the guidelines, but also made participants able to link sepsis with fever in a straightforward manner, as illustrated above by G, this is one of the reasons why many of them referred to the Sepsis Six bundle. As well as linking fever with infection, another reason for relating fever to sepsis was the emphasis of the Sepsis Six bundle. Take the excerpts provided by M and Participant 14 as examples.

> *When I qualified as a nurse, probably, that was about the time when sepsis was gaining a high profile. I remember when I was a student nurse, being aware of the changes in language around fever and the importance of sepsis. (M interviewee)*

> *Following the Surviving Sepsis campaign and national roll out of the Sepsis Six, there is greater emphasis on sepsis as a syndrome, than of fever as a numerical marker of illness. (Participant 14, questionnaire)*

It would seem that the Sepsis Six bundle has been successfully established. It was evident that, currently, the Sepsis Six bundle underpinned participants' thoughts about fever. Accordingly, fever relating to the Sepsis Six guidelines was one of the themes discovered throughout the thematic analysis. Participants 10, 19 and 24 described their rationale for management when encountering fever.

> *… following the Sepsis Six protocol. (Participant 10, questionnaire)*

> *… fever is considered a major indicator of sepsis and national protocol indicates for its timely management. (Participant 19, questionnaire)*

> *… patients with fever are scored using a verified sepsis tool*

and referred to hospital if required (Participant 24, questionnaire)

The above extracts illustrate that participants immediately think of the Sepsis Six guidelines when encountering fever. It would seem that the bundle had been successfully 'implanted' within the participant's mind and many other participants declared the same. The bundle, in addition, would affect their management attitudes towards fever. Figure 4.13 displays outcomes influenced by the Sepsis Six bundle. The evidence showed that both knowledge and management of fever could be affected by the Sepsis Six bundle. Moreover, the bundle added to the fear of fever for nurses. With the great success of promoting the Sepsis Six bundle, most of the nurses immediately linked sepsis with fever. As a result, it seems that both the rationalism or the intuitiveness of fever management was affected by the Sepsis Six bundle.

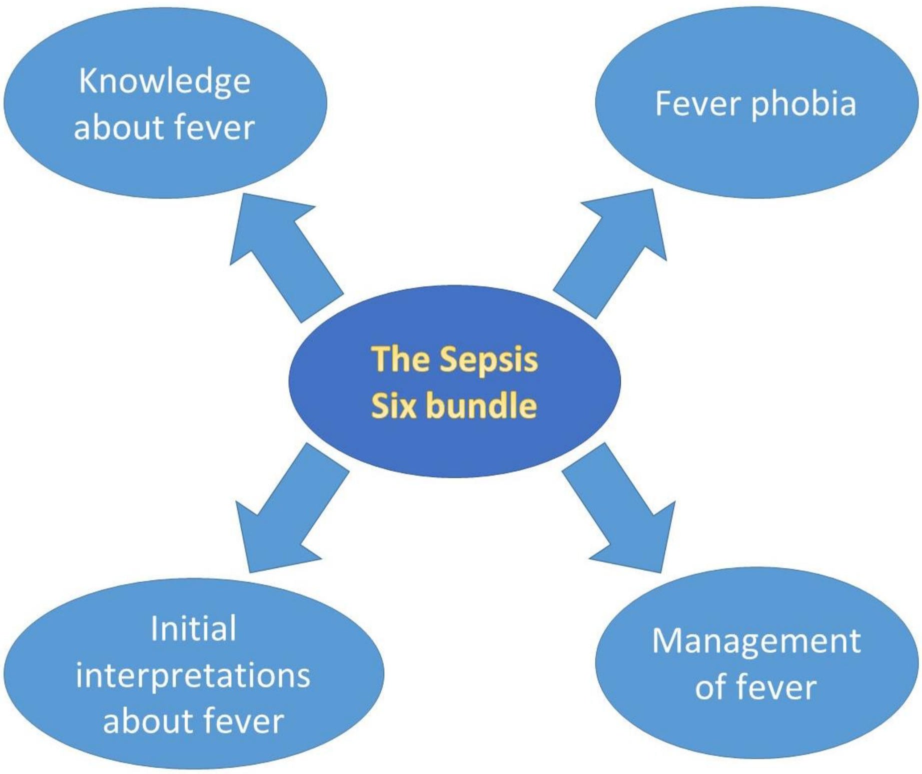

Figure 4.13 Influences from the Sepsis Six bundle.

In summary, confidence, education, access to new fever knowledge and the Sepsis Six bundle are all elements that influence the generation of knowledge about fever. Education about fever is often enhanced through experience of dealing with fever symptoms. Access to new knowledge has a positive relationship with the generation fever knowledge, while confidence is found to have a negative relationship with fever knowledge. However, the results of this study shows concern about lack of access to new knowledge about fever. It is also worth noting that the Sepsis Six bundle not only has an impact on the generation of knowledge about fever, but also influences the management and initial interpretations of fever. Moreover, it can reinforce fever phobia. In Figure 4.14, factors that are influenced by, or that influence knowledge about fever are presented in blue. Lack of fever knowledge includes lack of knowledge about the definition of fever, the purpose of fever, the use of antipyretics and the benefits and disadvantages of fever. Moreover, lack of knowledge about the use of antipyretics could influence how antipyretics are used when managing fever. While lack of knowledge about the benefits and disadvantages of fever could intensify fever phobia. The study also found that the way participants use antipyretics and their fever phobia were both related to how participants manage fever. A more detailed discussion about factors that were influenced by or that would influence fever management is given in the next paragraph.

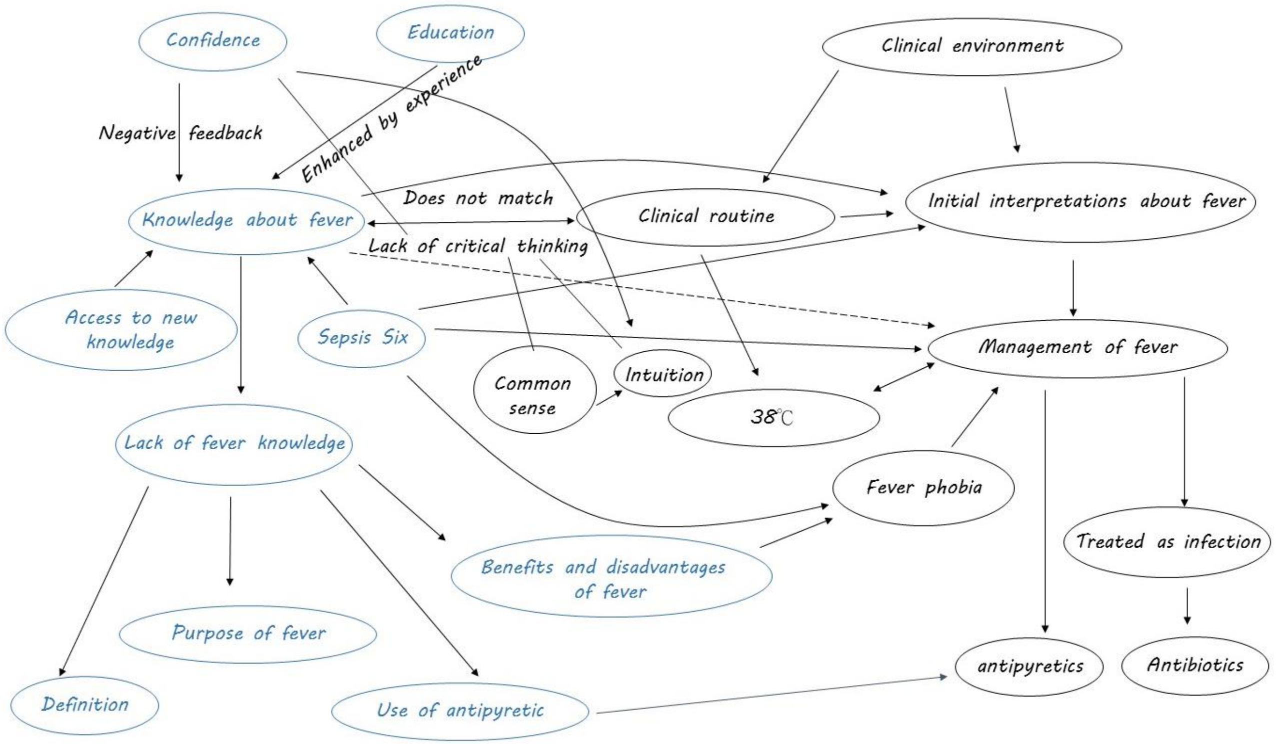

Figure 4.14 Multifactorial influences on knowledge about fever. The icons in blue are behaviours, factors, outcomes associate with fever knowledge, which was discussed in previous sections.

4.4.4 Factors relating to fever management

Interestingly, fever knowledge did not have a direct association with fever management. However, it was noted in Section 4.4.2 that fever knowledge had an impact on a nurse's initial interpretations about fever, and initial interpretations about fever could influence the nurse's overall management of the condition. The relationship between knowledge and management of fever was found to be indirect. Initial interpretations about fever represented what individuals would think about when encountering fever in the first place, which was the intuitiveness of the management of fever. This could include the causes of fever, its advantages and its disadvantages. The following quotes exemplified that the management of fever was automatic.

> *We automatically just do that … . (A interviewee)*

Interviewee A would connect a reaction towards fever automatically. Interviewee M made a similar statement.

> *The process of dealing with somebody who is very sick, often very septic patients go straight into the 'resus' rooms to be given fluids and to be assessed and all that kind of stuff, straightaway. It's almost like a processing line, people get packaged up and everything that needs to be done for them gets done. There is a good skill mix downstairs. People are ready and prepared to deal with these things straightaway. (M interviewee)*

M stated that management of fever was very straightforward. The results of interviews revealed that the initial interpretations about fever had a considerable effect on the management of fever, because it is a common occurrence in the clinical setting. Several elements could contribute to an individual's initial interpretations about fever. Discussions in prior sections (Section 4.4.3) about both fever knowledge and the Sepsis Six bundle showed associations between initial interpretations about fever and clinical environment. As demonstrated in Section 4.3.4.1, the clinical environment had an enormous impact on the participants' initial interpretations about fever. The nature of the clinical environment in particular would influence the participants' thoughts about the cause of fever. The statement of G, a registered nurse with a mental-health background, offered a case in point.

> *… and it could be that, you know, they may be are misusing substances and as a result there is stuff going on there. Things like new psychoactive substances. (G interviewee)*

It seems that G would firstly consider a mental-health issue as being the cause of the fever. Another similar example was given by C, who had an oncology background.

> *So I think temperature is one of the key things that we look out for with our observations because of the risk of neutropenic sepsis or just sepsis in general. (C interviewee)*

It was apparent that C would link fever directly to infection, or to infection caused by oncological treatments. Accordingly, the variety of experience in different clinical settings could broaden an individual's horizon in their initial interpretations about fever, as explained by M.

> *… the more information you have at your fingertips. You just need to know where to go and find it. (M interviewee)*

The results from the questionnaires also echoed the above statement, with the results showing a significant relationship between the number and variety of units at which participants had worked and their total knowledge score (see Section 4.3.2.1). Such testimony illustrates the effect the clinical environment has on participants' initial interpretations about fever. The clinical environment also had a close relationship with clinical routine, as presented in Section

4.3.4.1. On the oncology ward, for example, nurses would follow the neutropenic sepsis guidelines when managing fever, as illustrated by M.

> *Sometimes patients will have come back from theatre, from a procedure, and they have missed a dose of medication because they've been in theatre. You go, 'Oh, you've got a wee fever, but you've not had your paracetamol'. So we can give it then. (M interviewee)*

The nature of a surgical ward would influence the clinical routine when managing fever, and in this setting paracetamol was regularly prescribed for pain relief after surgery to maintain a constant analgesic level, and to reduce the amount of opioids needed. Therefore, many patients would have paracetamol routinely. However, interviewee M considered that not taking antipyretics was itself the cause of fever. Surprisingly, there were many participants who had the same thought. As a result, it appeared that the clinical environment had an impact on both an individual's initial interpretations about fever and their clinical routine to manage fever. The clinical routine, in addition, influenced the participants' initial interpretations about fever. Figure 4.15 illustrates the factors that were associated with the participants' initial interpretations about fever which then eventually influences fever management. The direction of each arrow indicates the direction of influence. The figure shows that the clinical environment could influence participants' initial interpretations about fever directly, and also indirectly by influencing their clinical routine. Knowledge about fever and the Sepsis Six bundle also influenced how participants initially interpreted fever. All the evidence suggested that initial interpretations about fever was one of the key factors that impacted fever management.

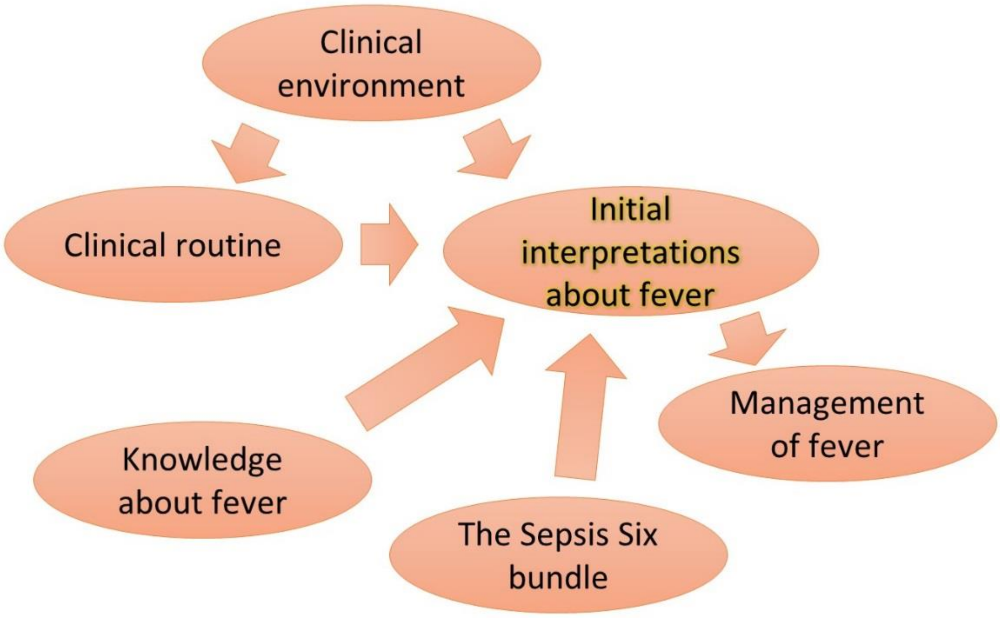

Figure 4.15 Factors related to initial interpretations about fever that affected the management of fever.

As well as influencing initial interpretations about fever, the clinical routine had an impact on the degree of temperature that the participants would tolerate before intervention. M explained at what temperature they would intervene with fever management in their clinical routine.

> *If somebody had a temperature over 37.6, and certainly in the 38s, then you would be thinking 'We need to deal with this'. … (M interviewee)*

Participant 26 also described her criteria for managing fever.

> *Guidance to treat any temp >38°C due to risk of sepsis. (Participant 26, questionnaire)*

Similar findings in both the qualitative and quantitative data revealed that the majority of participants would consider 38°C as the routine temperature to start managing fever (see Section 4.3.4.2). Moreover, they would deem 38°C as an indicator of pyrexia. One of the participants made an interesting comment about the temperature of 38°C.

> *Nurses are obsessed with any temperature above 38[°C]. Individual patients, circumstance and current management are not taken into account. (Participant 23, questionnaire)*

It seemed that 38°C not only acted as a signal to intervene, but the effectiveness of fever management very much depended upon hitting 38°C. Other factors that had an influence on the management of fever included the Sepsis Six bundle and fever phobia. The Sepsis Six bundle was underpinning the fever management, as many of the participants would intervene according to the official guidance despite the fact that the fever was not always a result of sepsis. Fever phobia was another issue underlined in the findings. The misunderstanding and reinforcement of the negative side effects of fever were the main reasons that participants decided to manage it.

The result of fever management suggested that antipyretics and antibiotics were both used as interventions to manage fever, especially pharmacological antipyretics which were commonly administered during a fever. The reason for routinely providing pharmacological antipyretics, mainly paracetamol, was the lack of knowledge about the rationale for administering antipyretics. The results from the questionnaire show that 82.49% of participants would use paracetamol as their primary intervention to manage fever (see Section 4.3.4.3). The analysis of the qualitative data shows similar results. Interviewee G gave an example of fever management.

> *… which is bad but we were kind of taught that if someone has an elevated temperature … give paracetamol. That's one of the things it's for. (G interviewee)*

It seemed that the managing fever was quite intuitive: participants would immediately administer paracetamol. However, some participants demonstrated that they had more updated knowledge about the use of antipyretics.

> *… The use of antipyretics will not prevent febrile convulsions - a large majority of nurses in my experience are very fever phobic. (Participant 31, questionnaire)*

Again, fever phobia was mentioned. From the results of this study, the use of antipyretics was for symptom management. It seemed that despite the lack of knowledge about the use of pharmacological antipyretics, the fear of fever was one of the issues driving participants to manage fever with antipyretics. Because most participants related fever to an infection, it was no surprise that many recommended the use of antibiotics to reduce the fever. According to Ferguson (2007) and Ames et al. (2013), infectious diseases were attributed to 50% of the causes of fever. In contrast to current evidence, the results of the questionnaire showed that more than 43% of the participants thought that fever was only caused by infectious diseases (see Appendix I). Moreover, many participants mentioned infectious disease as a fever cause while asking about its management. This finding agrees with the results from the qualitative data. Interviewee C detailed her management of fever in the following way.

> *Tepid sponging, removing layers, cold fan, paracetamol, ibuprofen if they are allowed it. … But obviously antibiotics are assisting in there as well … . (C interviewee)*

Likewise, interviewee R talked about her fever management.

> *We started him on, I think it was Co-amoxiclav (a type of antibiotic), before any of the samples had been sent away. Before we knew what was going on we started Co-amoxiclav. (R interviewee)*

It seems that antibiotics are the conventional way of managing fever. Factors that have an influence on fever management, or are influenced by fever management are illustrated in Figure 4.16. The direction of the arrows indicates the direction of influence, while the width characterises the strength of the association between items. An arrow that points in both directions indicates that the two factors can influence each other. For example, a high temperature could influence the fever management, while the fever management could influence the temperature, although this relationship was not as strong as the relationship between other factors. Fever management could be influenced by the initial interpretations about fever, fear about fever and the Sepsis Six bundle; while the fever management itself could impact the administration of antipyretics and antibiotics. Because fever was often considered to be a sign of an infection and was treated as an infection, fever management frequently included the administration of antibiotics.

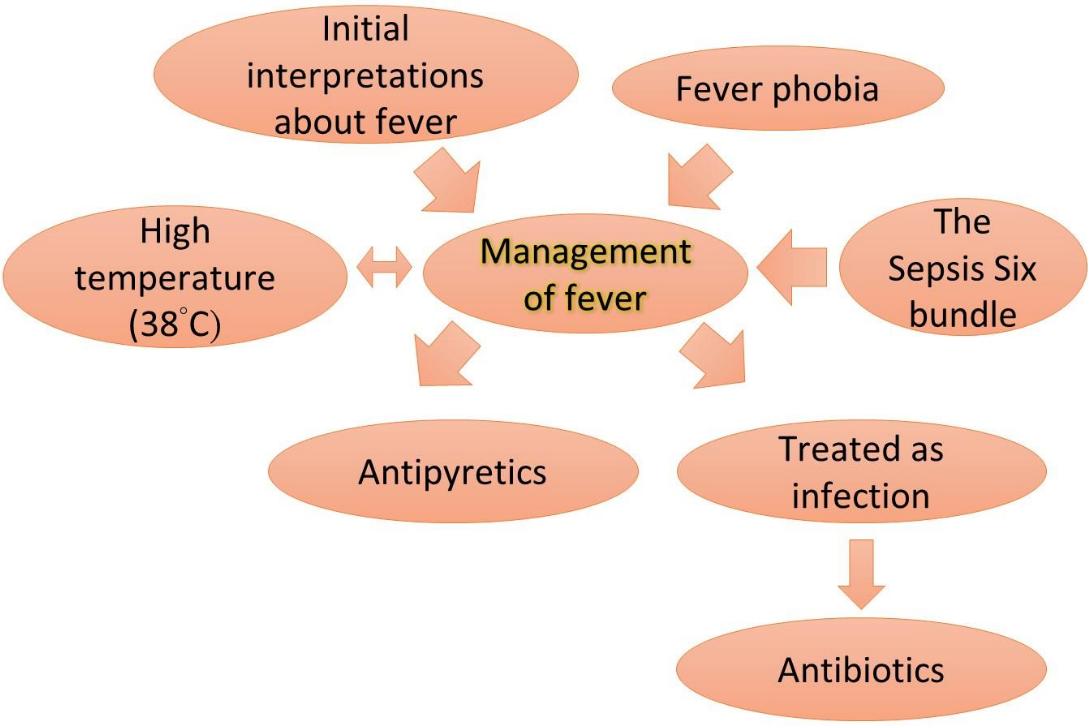

Figure 4.16 Behaviours, factors relating to fever management, which is highlighted in yellow, and outcome of fever management. There is an explicit figure above (Figure 4.15) demonstrating factors related with initial interpretations about fever.

To sum up, the initial interpretations about fever, which is the first impression a participant gets about the symptoms when observing a febrile patient, could be influenced by knowledge of fever, the clinical setting and the guidelines. Several factors, including the initial interpretations about fever could influence its overall management. Fever management was categorised into the use of antipyretics and antibiotics. Because fever is often being considered to be a sign of infection, antibiotics were found to be one of the most common managements when dealing with fever. In Figure 4.17 factors, behaviours, outcomes associated with fever management are shown in red. As previously stated, initial interpretations about fever, the Sepsis Six bundle, a high temperature (38°C) and fever phobia could influence fever management. The clinical environment and clinical routine could both influence the initial interpretation about fever and then impact fever management. Clinical routine could also influence how a participant defined the high temperature. For instance, the haematology unit might have a tighter threshold for a high temperature compared to that of a surgical unit. Consequently, the clinical environment can influence at what temperature the participant starts their fever management. As for the Sepsis Six bundle, it can directly influence participants’ management of fever by enhancing their fears about fever. Figure 4.17 also shows that the three common fever managements were monitoring a high temperature, administering antipyretics and administering antibiotics. It was worth noting that the reason for using antibiotics to manage fever was because fever was often treated as infection.

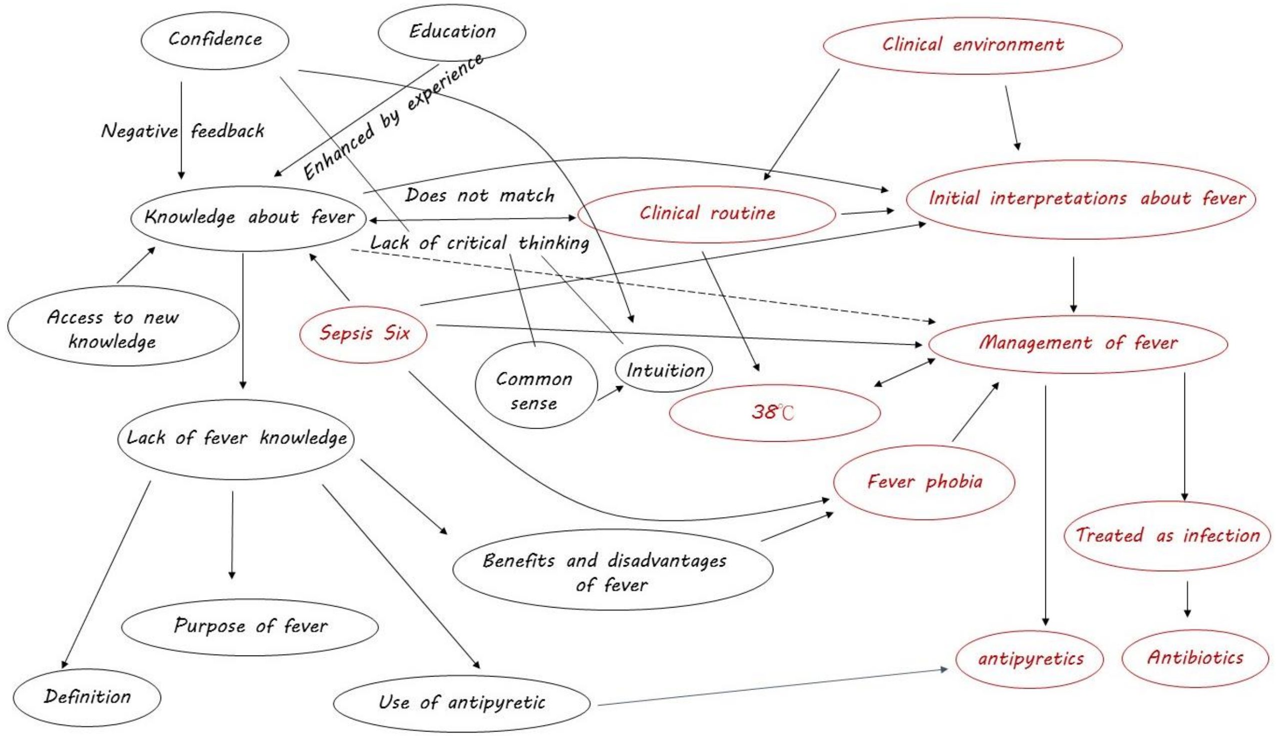

Figure 4.17 Multifactorial influences on management of fever. The icons in red are behaviours, factors, outcomes associate with fever management, which was discussed previously in this section.

4.4.5 The links between fever knowledge and fever management

The analysis of the results showed no direct relationship between knowledge about fever and its management. However, several elements were found to be attributed to both fever knowledge and fever management, connecting the knowledge and management of fever. The Sepsis Six bundle was found to influence both fever knowledge and fever management. Additionally, the two factors that played an important role in connecting knowledge and management of fever were the participants’ initial interpretations about fever and their fear about fever. As introduced in Section 4.4.2, an individual’s knowledge about fever could influence their initial interpretations about it, thereby having a huge impact on its management. Therefore, through initial interpretations about fever, fever knowledge and fever management were somehow ‘bonded’ together. Another factor that brought knowledge and management of fever together was fever phobia. As discussed in Section 4.2.2, it seems that lack of knowledge about fever, especially about its benefits and disadvantages, enhances the participants’ fear when encountering fever because they had less knowledge about its benefits and over exaggerated its side effects. Fever phobia is therefore associated, not only with level of knowledge about fever, but also with the management of fever. Because of this fear of fever, antipyretics were the most popular way to manage it. Interestingly, the lack of knowledge on the use of antipyretics also associated with rationales to manage fever. It was found that due to participants did not fully understand the disadvantage of performing antipyretics or the side effects of antipyretics, they would like to intervene fever. As a result, concerns about lack of overall knowledge about fever were identified in the results from the questionnaire. Moreover, it was found that the participants’ management of fever was not in accordance with current scientific evidence. Although the issue of outdated fever management was noted in this study, it seemed that only a few participants pointed out this issue. Take the excerpt from Participant 13 for example.

> *I have been under the impression and the guideline states that paracetamol should not be used to reduce temperature but for pain, but a lot of clinicians are still telling patients to get the temp down. I was under the impression that it was the body's response to kill the infection and if we took the temp down the infection could last longer. (Participant 13, questionnaire)*

Participants had the same opinion about inadequate management of fever:

> *I think that we intervene too quickly in the hospital environment. (Participant 15, questionnaire)*

The lack of the participants' awareness of the guidelines for fever management posed concerns when making decisions about the management of fever. It would seem that their knowledge about fever did not match the clinical routine for managing fever. For example, the participants understood the disadvantages of non-pharmacological antipyretics, yet they would still choose to use these antipyretics to manage fever. This finding was highlighted in both the quantitative and the qualitative data. It was found that only a few associations between non-pharmacological external antipyretics and knowledge about pharmacological antipyretics were identified. The answer to Question 17, which concerned the use of external cooling, was noted to have a significant association ($p=0.001$) with participants who chose cool air as their first choice of fever management. Although the association was weak ($Phi=0.243$), this result showed that participants who understood the use of external antipyretics correctly chose cool air to manage patients with fever (Table 4.43). The answer to Question 22, on the side-effects of active cooling, was found to be significantly associated with participants who chose tepid sponging as their second choice of external antipyretic ($p=0.019$). It was discovered that participants who had accurate knowledge of the side effects of active cooling were less likely to choose tepid sponging for their second choice of fever management (Phi=-0.177), although the association was very weak (Table 4.44). The answer to Question 22 was also found to be significantly associated with participants who selected using a fan as their third choice of fever management (p=0.007). It seemed that participants who answered Question 22 correctly tended to choose a fan for their third choice of fever management, although the relationship was not strong (Phi=0.203, Table 4.44).

Q17x			**Cool air**		**Pearson's chi-square test**	
First choice of fever management- cool air			O	X		
Q17	-1	Count	87	3	Value	10.467
		Expected Count	80.3	9.7	df	1.000
	1	Count	71	16	Asymp. Sig. (2-sided)	*0.001
		Expected Count	77.7	9.3		
Nominal by Nominal			Phi			0.243

Table 4.43 Cross tabulation of Question 17 and cool air as first choice of fever management. 1 indicates correct answers, -1 indicates wrong answers, 'O' means participants who did not choose cool air as their first choice of fever management, while 'X' means participants who chose cool air as their first choice of fever management, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability,

Q22x Second choice of fever management- Tepid Sponging			Tepid Sponging		Pearson’s chi-square test	
			O	X		
Q22	-1	Count	85	21	Value	5.532
		Expected Count	90.4	15.6	df	1.000
	1	Count	66	5	Asymp. Sig. (2-sided)	*0.019
		Expected Count	60.6	10.4		
Nominal by Nominal			Phi			-0.177
Q22x Third choice of fever management- Fan			**Fan**		**Pearson’s chi-square test**	
			O	X		
Q22	-1	Count	91	15	Value	7.288
		Expected Count	83.8	22.2	df	1.000
	1	Count	49	22	Asymp. Sig. (2-sided)	*0.007
		Expected Count	56.2	14.8		
Nominal by Nominal			Phi			0.203

Table 4.44 Cross tabulation of Question 22 with tepid sponging as second choice of fever management and fan as third choice of fever management. 1 indicates correct answers, -1 indicates wrong answers, ‘O’ means participants who did not choose cool air as their first choice of fever management, while ‘X’ means participants who chose cool air as their first choice of fever management, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability,

The association between answers to questions about external antipyretics and other choices of methods in fever management was not found to be significant (see Appendix K). Therefore, having a better understanding about non-pharmacological antipyretics seemed to have little influence on the participants’ choice of non-pharmacological antipyretics. The same theme was demonstrated in the interviews:

> *I did read somewhere something about tepid sponging being out of date … and I was still using that, so the answer to that is yes (laughs). Although, to be honest with you, I still think that it's a great way of getting the temperature down. (A interviewee)*

The quotation indicated that the participant might have been aware of the evidence about tepid sponging. Yet she was still keen to use tepid sponging when managing fever. Another analysis was used to compare knowledge and use of pharmacological antipyretics. No association was found between the answers to the questions about antipyretic medications, Questions 20, 21, 23 and 24, and participants who chose paracetamol as their preferred method to manage fever. This showed that the selection of pharmacological antipyretics for fever management would not be influenced by knowledge of pharmacological antipyretics. The interviews suggested the same.

> *Yes, I suppose though sometimes you will give paracetamol for somebody who is symptomatic and it will have no effect. (C interviewee)*

It would seem that although Interviewee C was aware of the likely outcome of paracetamol usage, they would still provide it in order to manage fever. It was evident that there was a considerable gap between participants' knowledge about fever and their management of it. Therefore, an analysis was conducted to look for an association between knowledge about the benefits and disadvantages of fever, and thoughts about controlling fever. The results showed that there was only a slight relationship between those two items. Only the answers to Question 27, which was about the primary danger of fever, showed a significant association with the answers to Question 28, which was about whether controlling fever could reduce the length of a patient's hospital stay. The Pearson's chi-square between those two questions was 0.035. However, the Phi was -0.159, indicating that participants who understood the primary danger of fever more correctly tended to think that controlling fever could decrease the length of a patient's hospital stay. Thus, the association was not considered to be strong (Table 4.45). This finding was quite shocking. It would seem that the lack of significance implied that there was a gap remaining between participants' knowledge of fever and their thoughts about fever (see Appendix J). Moreover, the significance of the relationship between participants' thoughts about fever and fever knowledge revealed the existence of the gap. The results from the overall analysis of the relationship between fever knowledge and fever management suggested that this is not a consistent relationship. However, participants were not aware of the differences between their knowledge of fever and clinical routine to manage fever. Consequently, the question remained as to why the gap between fever knowledge and fever management, which was considered obvious in this study, was not noticed by the participants.

Q27xQ28			**Q28**		**Pearson's chi-square test**	
			Increase+ Not sure	Decrease		
Q27	-1	Count	17	118	Value	4.448
		Expected Count	21.4	113.6	df	1.000
	1	Count	11	31	Asymp. Sig. (2-sided)	*0.035
		Expected Count	6.6	35.4		
Nominal by Nominal			Phi			-0.159

Table 4.45 Q27 and Q28 cross tabulation. 1 indicates correct answers, -1 indicates wrong answers, df means degrees of freedom, Asymp. Sig. means asymptotic significance, * indicates significant probability.

4.4.6 Lack of critical thinking

Lack of critical thinking, which was one of the themes generated in the study, was one of the factors that contributed to the gap between the participants' fever knowledge and their fever management. It was found that participants believed they knew everything about fever, and hence did not question their own knowledge or management of it. The following quotations showed that participants tended not to think critically in the clinical environment. When asked about the reason for not questioning their knowledge about fever, Interviewee C gave the following answer.

> *I suppose because it’s not directly relevant to management. (C interviewee)*

It seems that Interviewee C did not link their fever knowledge directly with fever management. M further expanded upon the reasons for not bringing fever knowledge and management together.

> *… There were often a lot of things that nurses did without understanding completely about reasons for doing it. Usually, those managements were considered as common sense. (M interviewee)*

Because fever is a common occurrence in the clinical setting, participants did not think about the reasons for fever nor did they try to improve their understanding of it. It seemed as though common sense prevented participants from connecting fever knowledge and fever management. It was difficult for participants to connect the rationale for fever management with their fever knowledge, especially when they were not aware of this mismatch between their own knowledge and management. Yet even when participants did notice the differences between their fever knowledge and management, it was still likely that they would not think critically about the differences.

Interviewee R spoke about some observations in fever knowledge and fever management.

> *I’m not sure if there is much consistency. (R interviewee)*

She then continued about whether she would doubt her own clinical management of fever.

> *Sometimes … . But then I think, is it just because of my experience? I've not had much experience, so I don't … . (R interviewee)*

It seems that even though she had some questions about fever knowledge and management, she was not confident enough to raise the question because she thought she might not be experienced enough. Not feeling confident enough to doubt their own clinical management was a concern raised by many participants. This, once again, demonstrated the importance of confidence. On the other hand, too much confidence could result in an overall lack of critical thinking or questioning as explained by Interviewee C.

> *Even in my current post, I haven't felt the need to go and look it [knowledge about fever] up. … I have never even. Yes, never even questioned it [knowledge about fever]. (C interviewee)*

It seems that overconfidence, as well as a lack of confidence, can lead to a lack of reflection. Common sense was another factor that caused a lack of critical thinking. Because fever is frequently observed and treated, participants considered the current fever management, or the clinical routine of treating fever, as something that 'ought to be done'. Despite those two factors, intuition was also found to be one of the key factors which influenced their ability to think critically. Interviewee G made the following statement when talking about decision making for managing fever.

> *I think it's all intuitive things. (G interviewee)*

Interviewee M also explained the intuitiveness of fever management as before.

> *The process of dealing with somebody who is very sick, often*

> *very septic patients go straight into the 'resus' rooms to be given fluids and to be assessed and all that kind of stuff, straightaway. It's almost like a processing line, people get packaged up and everything that needs to be done for them gets done.*
>
> *People are very practised at what happens. Often you'll get a crash call with a septic patient, or suspected sepsis, patient arriving in 10 minutes. You know you know that they're coming in and you're going to do those Sepsis Six things straightaway. You've got people who are doing all that stuff. 'Obs', bloods and everything at once … . People are ready and prepared to deal with these things straightaway. (M interviewee)*

It was not difficult to notice that 'straightaway' was mentioned several times in the above quote. It seemed like fever management was decided automatically and the participant's professional intuition directed that management. It was also noted that participants were confident while talking about their intuition in fever management. Through the generation of the theme, the results showed that common sense could cause intuitiveness and affect intuitiveness in fever management as well. As described in a previous field note with M.

> *… there were often a lot of things that nurses did without understanding completely about reasons of doing it. Usually, those managements were considered as common sense. (Interviewee M, field note)*

As M mentioned, there were often a lot of things that nurses did without completely understanding the rationale behind them. Usually, those managements were deemed as common sense, which usually would not be explained by your colleagues and nurses would performed the managements directly without thinking about it. The excerpt below demonstrates how this rationale system was prompted.

> *… the participant felt that he never thought about the rationale behind the 'usual' administered managements. It was after his role as a research nurse and the completion of fever questionnaire, he thought carefully about whether the usual managements were evidence based or not. (Interviewee M, field note)*

To conclude, the three elements that led to a lack of critical thinking were confidence, common sense and intuition. Both common sense and confidence could trigger intuition. As a result, a lack of critical thinking caused the mismatch between fever knowledge and management. Figure 4.18 sums up the factors that contribute to the differences between fever knowledge and fever management as discussed in this section, which are shown in green.

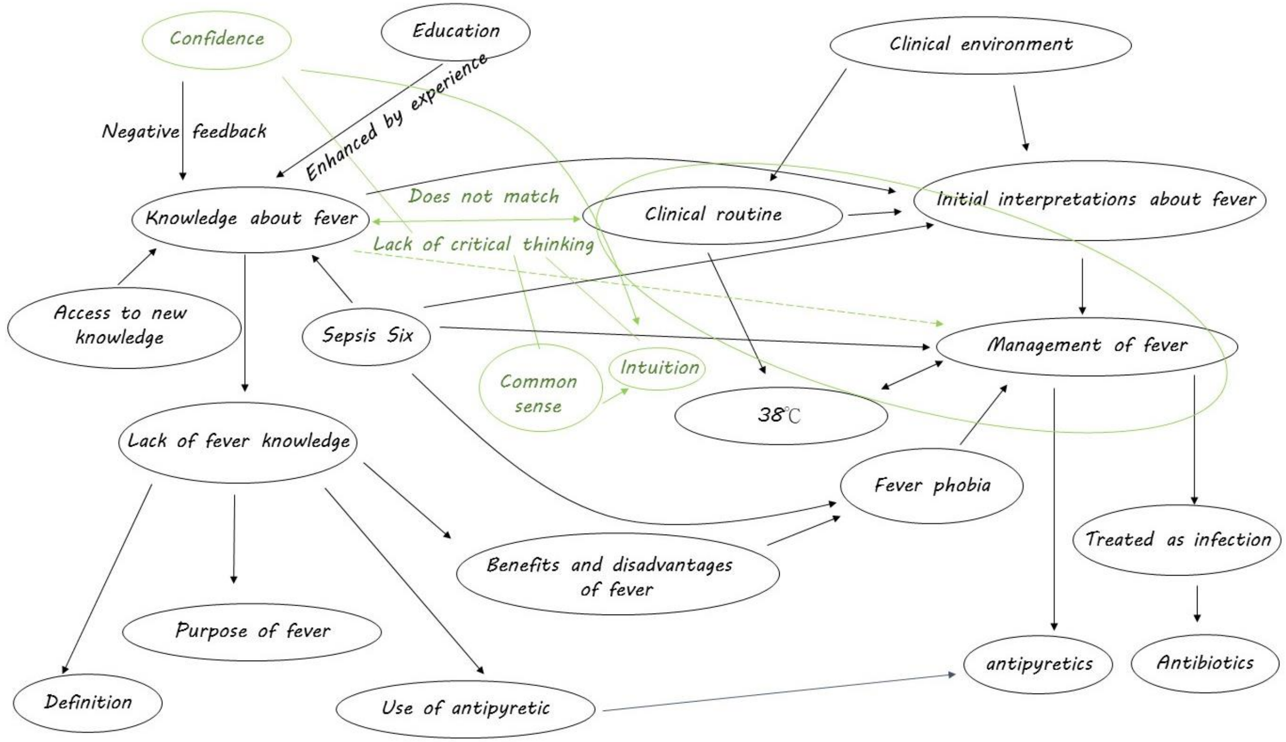

Figure 4.18 Icons and descriptions in green are those associated with the mismatch between fever management and fever knowledge.

4.5 Summary

The participants expressed concern about their overall lack of fever knowledge. Although the clinical practice experience helped to improve their fever knowledge, the lack of access to new information about fever made their learning more difficult, especially nowadays when knowledge is updated rapidly and regularly. Confidence, education, guidelines associated with sepsis, clinical experience and critical thinking were all found to be vital elements that influenced fever management. The finding that confidence had a negative association with knowledge of fever was especially noteworthy. Accordingly, the more confident a person was, the less they would seek to acquire accurate knowledge.

Clinical experience also influenced the participants’ initial interpretations when managing fever, having both a direct and an indirect influence on the nurses’ approach. It was discovered that nurse’s initial interpretations about fever would be influenced by clinical routine. Additionally, both initial interpretations about fever and clinical routine were factors that would impact nurses’ fever management. Before commencing fever management, observations of various symptoms affect the nurses’ decision-making process. Moreover, fever phobia and the discomfort caused by fever were among the key elements that prompted nurses to initiate fever management. As the connection between sepsis or infection and fever was often made, one of the common approaches in fever management was to provide antibiotics.

It was found that paracetamol was often used to reduce a patient’s temperature and to ease their discomfort during fever. The participants seemed to have good knowledge about the use of paracetamol, which they would often administer to manage fever. However, a concern about lack of fever knowledge was identified, especially about the benefits and disadvantages of fever, not to mention the very definition of fever and its biological purpose. It was also found that fever fear or fever phobia was associated with a lack of knowledge about the benefits of fever.

Inconsistency between knowledge of fever and management of fever was noted. However, it was found that nurses rarely took steps to reduce the gap between the two, mainly because of a lack of critical thinking. It was apparent that an openness to critical thinking played an important role in motivating nurses to find ways to bridge the gap between the clinical evidence and their knowledge of fever. Without a critical-thinking process, the gap between evidence and knowledge of fever would become insurmountable and be taken for granted. The lack of critical thinking had a positive relationship with clinical confidence, showing that the more confident a person was, the more they lacked critical thinking. The majority of participants used their independent nursing judgment when making decisions regarding the management of fever. The results indicated that independent judgments tended to be drawn from the participants' knowledge and experience, and from clinical guidelines.

Details of the factors that were found to relate to fever knowledge and fever management have been stated in this chapter. Nurses' knowledge about fever was explored and discussed in this study. It was found that the nurses expressed concern about their lack of up-to-date fever knowledge. Key elements that contribute to fever knowledge were identified in the study and factors affecting fever knowledge have been suggested. Different approaches taken to manage fever were found to be associated with a variety of elements, including knowledge, clinical environment and anxiety about fever. The connection between knowledge and fever management was established. It was found that initial interpretations about fever, the Sepsis Six bundle and fever phobia were three of the key elements that influenced fever knowledge and management. Interestingly, no association was found between fever knowledge and the management of fever. The main reasons for this lack of association were a lack of critical thinking on the part of the participants, and their belief that managing fever was down to common sense. As a result, participants tended to make decisions based on their intuition. Figure 4.19 sums up the overall relationships between the factors that affect the management of fever.

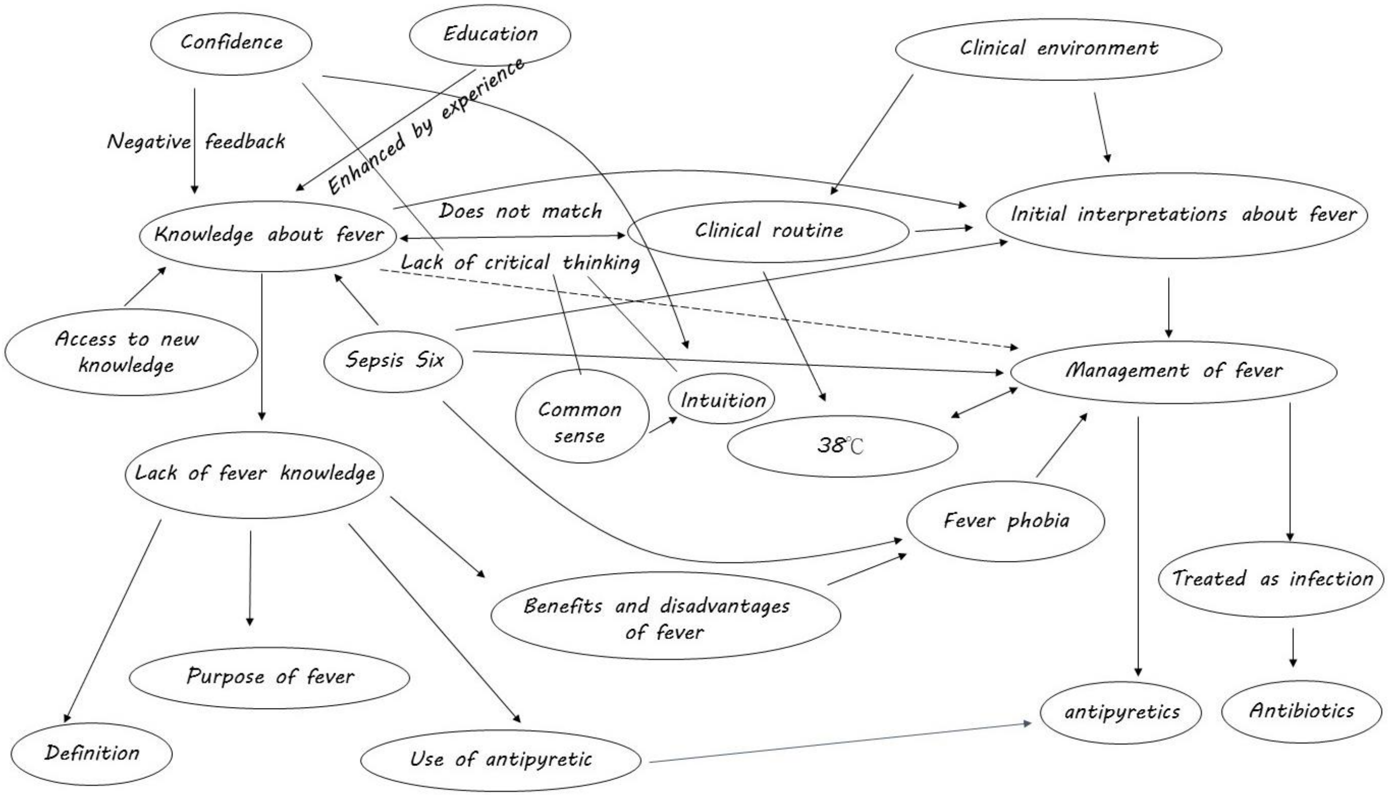

Figure 4.19 Factors influencing knowledge about fever and management of fever.

CHAPTER FIVE: DISCUSSION

5.1 Introduction

The results presented in Chapter 4 introduced the factors that influenced nurses’ knowledge and management of fever, these factors will now be discussed further.

One of the key findings of this study was the mismatch between participants’ fever knowledge and their fever management. Therefore, the ways these mismatches develop are discussed. The results of this study also demonstrated that participants’ fever knowledge was of concern. To investigate this issue, the concept of how they develop their fever knowledge is explored. The knowledge-building process of established evidence is compared with the results from this study. It was found that a part of the knowledge into management framework matched the result related to fever knowledge. There are two types of knowledge – tacit and explicit – the differences between the two are identified and discussed. The knowledge-creation model is adopted alongside the concept of tacit and explicit knowledge in order to understand how knowledge about fever is acquired. Moreover, regarding the knowledge-building process, this chapter further investigates how knowledge interacts with experience and becomes action. It is worth noting that the intuitiveness and rationalism of the knowledge was stated, which is associated with the dual process theory of decision making.

The results of the questionnaire showed that the majority of participants based their fever management on their own independent professional judgement. An investigation into independent professional judgement was then conducted and it was discovered that knowledge of fever, experience and awareness of the Sepsis Six bundle, all had an influence on an individual’s independent professional judgement. The findings were then compared with clinical decision-making theories. The concept of the dual process theory in a healthcare setting was found to be very similar to an individual's decision-making strategy. By amending the dual process theory, a new dual process theory for fever has been generated and is presented here in Chapter 6.

According to the results of this study, the use of the Sepsis Six bundle has played an important role in influencing both fever knowledge and fever management. This chapter, therefore, discusses this influence and debates the prudent use of the bundle. The debate includes a discussion on how protocols or guidelines should be adopted. As there has been a trend for standardising clinical practice, the advantages and disadvantages of standardisation are explored.

Following the standardisation of health care based on guidance, the 'Bandwagon' effect is introduced to discuss the standardisation of health care resulting from peer pressure in the absence of guidance. Finally, this chapter focuses on the outcomes of over treating fever and discusses the reasons for using antipyretics.

5.2 Nurses' knowledge of fever

The result of this study demonstrated that nurses' knowledge about fever is of concern (Section 4.3.2.2). This result resonated with studies in the literature review. Most surveys showed that nurses had poor understanding about fever (Greensmith, 2013; Kiekkas et al., 2014). In this study, the temperature defined as fever, disadvantages of fever and the causes of fever are the three main questions that participants answered poorly. Similarly, a study by Chiu (2012) showed that most participants misunderstood the mechanism of fever. Greensmith (2013) illustrated that most of their participants did not understand the principal dangers of fever. It would seem that despite the temperature defined as fever, the result of the other questions, such as disadvantages of fever and causes of fever were both poorly understood in some studies (Chiu, 2012; Greensmith, 2013). Although no published article was found that discussed nurses' understanding of a fever definition, many articles suggested that nurses would immediately reduce the body temperature in a fever situation (Chiu, 2012; Greensmith 2013; Kiekkas et al., 2014).

A few factors were found to have a significant relationship with fever knowledge, such as the variety of experience and confidence. Moreover, when analysing the total score with participants' experience, it was found that participants who had experience in critical care, acute care or 'other' units demonstrated a significantly higher mean rank on their total knowledge score than those working in a rehabilitation unit or non-hospital setting ($p \leqq 0.05$), (see Table 4.15) However, the association was weak. The study conducted by Kiekkas et al. (2014) had a similar result with participants from different units. It showed that nurses in critical care, medical care and surgical care had significantly different fever knowledge scores. Although some associations with the participants' unit and total knowledge score were found, no strong association between fever knowledge and other factors were found. This suggests concerns about fever knowledge is general. Accordingly, insufficient knowledge of fever could apply to nurses from different clinical environments with different backgrounds. Similar situations were found among other knowledge questions. Some associations between knowledge questions asking about same topic, for example, mechanism of fever, definition of fever temperature and antipyretics were found. However, the associations were not strong (see Appendix G). Accordingly, a lack of overall knowledge of fever was noted.

The individuals' knowledge base acted as a resource in their information processing. During the decision-making process, people employ knowledge in order to make a judgement, which becomes an action. Even though, theories about how knowledge plays a part in the decision-making or management were different (see Chapter 1). They all agreed that knowledge played a vital role in decision-making (Welsh and Lyons, 2001; Woolf et al., 2005; Graham et al., 2006; Straus et al., 2009; Straus et al., 2011). Therefore, having up to date and sufficient knowledge is important, because it might have an impact on decision-making and management (Chan Kim and Mauborgne, 1998; Courtney, 2001; Yu, 2010; Straus et al., 2011; Islam et al., 2017). The following excerpt from M demonstrated that fever knowledge was a part of fever management.

> *From the very basic, one of the very first things that you learn when you're training is that these are the normal temperature ranges that you're looking for. If a patient is over that or below that, then immediately, that's knocking the homeostasis out of balance and that's not a good thing because you want to maintain that balance… the proper temperature. (M-interviewee)*

It would seem that knowledge about fever could influence fever management. While evidence has suggested that knowledge could influence the decision-making process and subsequent management, the result of the questionnaire showed that the association between fever knowledge and fever management was poor. Even when an association was noted, the relationship was not strong (see Appendix K). As displayed in Section 4.4.5, 4.4.6 and Figure 4.18, gaps between fever knowledge and fever management were found. Interviewee R also stated her thoughts about the mismatch between fever knowledge and fever management.

> *I think in the next few years, what will happen is that the classroom information and the patient information will come together and I'll have the both knowledge appropriately. (R-interviewee)*

It would seem that knowledge from education did not relate to information from clinical practice. It would seem that the knowledge and understanding is cultural and could engage with different factors.

Carper's ways of knowing in nursing (1978), as illustrated in Section 1.2.1, identifies four types of knowledge, which are the empirical knowledge, aesthetic knowledge, personal knowing, moral knowing. Empirical knowledge, which is based on scientifically validated evidence that can be applied in nursing practice; aesthetic knowledge, regarded as the art of knowing, which focuses on the process of knowledge application; personal knowledge, which encompasses self-knowledge, knowing others and the relationships between individuals; and lastly, moral knowledge involving the clinician's ethical stance in nursing practice. White (1995) proposed a fifth type of knowing, which was called socio-political knowing. This type of knowing referred to a type of interaction between nurses and the environment suggesting that consideration about individual's culture should be brought into a larger scale, which formed the socio-political knowing. According to Carper's ways of knowing, the fever knowledge in this study included the empirical knowledge, which referred to the use of guidance, aesthetics knowledge, which referred to the application of the knowledge, personal knowledge, which is understanding individuals and socio-political knowing, which referred to the enculturation of nurses and individuals. Elements in different types of knowledge were observed in the fever knowledge of this study. However, moral knowledge was not mentioned in this study. Although Carper's ways of knowing (1978) helped to understand different types of knowledge, some studies have criticised Carper's ways knowing as overly conceptual and not representing the process of nursing (Fawcett et al., 2001; Estabrooks et al., 2006). As for moral knowing in this study, it would seem that participants' moral priority was to keep their patients comfortable. Consequently, they prioritised the moral knowledge over understanding how pyrexia related to the underlying cause. Interviewee R made the following comment when asked about when to intervene for fever symptoms.

> *Because, obviously, if he had the high temperature, we knew that was making him more uncomfortable. (R interviewee)*

It would seem that for interviewee R, the most important agenda was to make patients comfortable and reducing fever would achieve that. Another excerpt by M illustrated a similar point of view.

> *I don't know. Maybe it's just the type of patients that I've seen in different wards. Particularly in surgical wards, it's just the classic first line pain relief. It's just a fairly common medication for a lot of people to be on. Most people who were on that medication would be on a four times a day regimen. (M interviewee)*

As previously stated, it is a routine to administer paracetamol for post-operative patients. However, nurses would consider failing to administer paracetamol as the reason for pyrexia. The above excerpt by M exemplified the reason of providing routine paracetamol, which was for the purpose of relieving pain. It could, therefore, be argued that providing routine paracetamol was also due to moral knowledge in the case of fever.

As presented in Section 4.4, many factors could influence the process of knowledge generation, especially clinical culture and personal confidence. Those factors seem to impact on the personal knowledge and socio-political knowledge, as the knowledge generation process in fever has engaged with clinical culture and personalisation. Eventually, the personal knowledge and socio-political knowledge would influence the application of knowledge. It is argued that the elements of aesthetic knowledge, personal knowledge and socio-political knowledge seem to be similar in this fever study. Although Carper's ways of knowing categorised different types of knowledge and different knowing processes, it was not easy to translate this theory into everyday practice (Fawcett et al., 2001; Estabrooks et al., 2006). Moreover, it would seem that gaps exist between empirical knowledge, aesthetic knowledge and personal knowledge. Therefore, the following section discusses the process of mismatch between knowledge and management from the knowledge-building process to decision-making.

5.3 Knowledge into action framework

The relationship between fever knowledge and fever management has been discussed in previous sections (4.4.5 and 4.4.6). In Section 1.2, different types of knowledge into action theories were examined. The knowledge into action framework describes how new research knowledge is transferred into action, which mainly focused on promoting the new intervention or policy. However, there were a few theories that could be used to describe the clinical practice into knowledge transfer process (Ward et al., 2009). Three different types of knowledge transfer process were identified, namely linear, cyclical and a dynamic multidirectional process. The linear process model generated by Davis et al. (2003) shows a progression from raising awareness of evidence within groups to ensuring adherence to the evidence (as in Table 1.1). This model focuses on disseminating new information into groups of people and through discussion within the groups, interventions are chosen in accordance with the latest scientific evidence. The linear process suggests that the model retains a focus on identifiable start and end points. Graham et al. (2006) produced a knowledge into action model using a cyclical process. Figure 1.1 demonstrates the knowledge into action model, which was the most frequently used model for transferring knowledge in health care settings. This model includes aspects of research, context, knowledge-transferring intervention and evaluation. As shown in Figure 1.1, there are two parts to this model, the knowledge-creation triangle and the action cycle. The knowledge-creation triangle details the development of the process. The general knowledge part from the knowledge-creation triangle would be tailored once the knowledge was synthesised. Eventually, the synthesised knowledge becomes a knowledge product and can be applied in the action cycle. The action cycle starts by utilising the knowledge products, then proceeds by assessing the knowledge. After evaluating the knowledge use, interventions are applied followed by the monitoring and evaluating processes. Finally, if the outcome of the interventions is positive, then the use of the knowledge is sustained. However, if the outcome of the knowledge use is negative, problems should be identified and the knowledge-creation cycle starts again alongside the action cycle. This overall process of transferring knowledge into action, described by Graham et al. (2006), is most frequently used in the healthcare setting and is promoted by the WHO in generating new policy. As for the dynamic multidirectional model, the individual components in the process are not linked in a linear fashion, but can occur simultaneously, or in different sequences. This type of transferring knowledge-into-action process could be represented by the Greenhalgh et al. (2004) model. This model emphasises the personal nature of the process by focusing on the degree of linkage and exchanges between the producers and the targets of the research (Figure 7.9). Both of the linear and multifunctional models highlight the process of transferring new research knowledge to a specific group of people. The components of both models not only concentrate on applying new research knowledge, but also engage from the socio-political aspect. The results of this study, however, did not match those frameworks reviewed in Chapter 1 because they focused mainly on the application of knowledge to a specific group of people, while the results of this research studied the knowledge of individuals. In addition, the relationship between knowledge and management in this research did not include the selection of intervention, which was described before the implementation of the action and illustrated in many frameworks, nor the evaluation of the knowledge. However, the knowledge-creation part of Graham et al.’s (2006) framework is similar to the factors related to fever knowledge in this study, especially the process of generating knowledge. Therefore, Graham et al.’s (2006) framework was adopted to understand the creation of fever knowledge. As previously discussed, education, the Sepsis Six guidelines and the variety of experience all influence and enhance knowledge about fever.

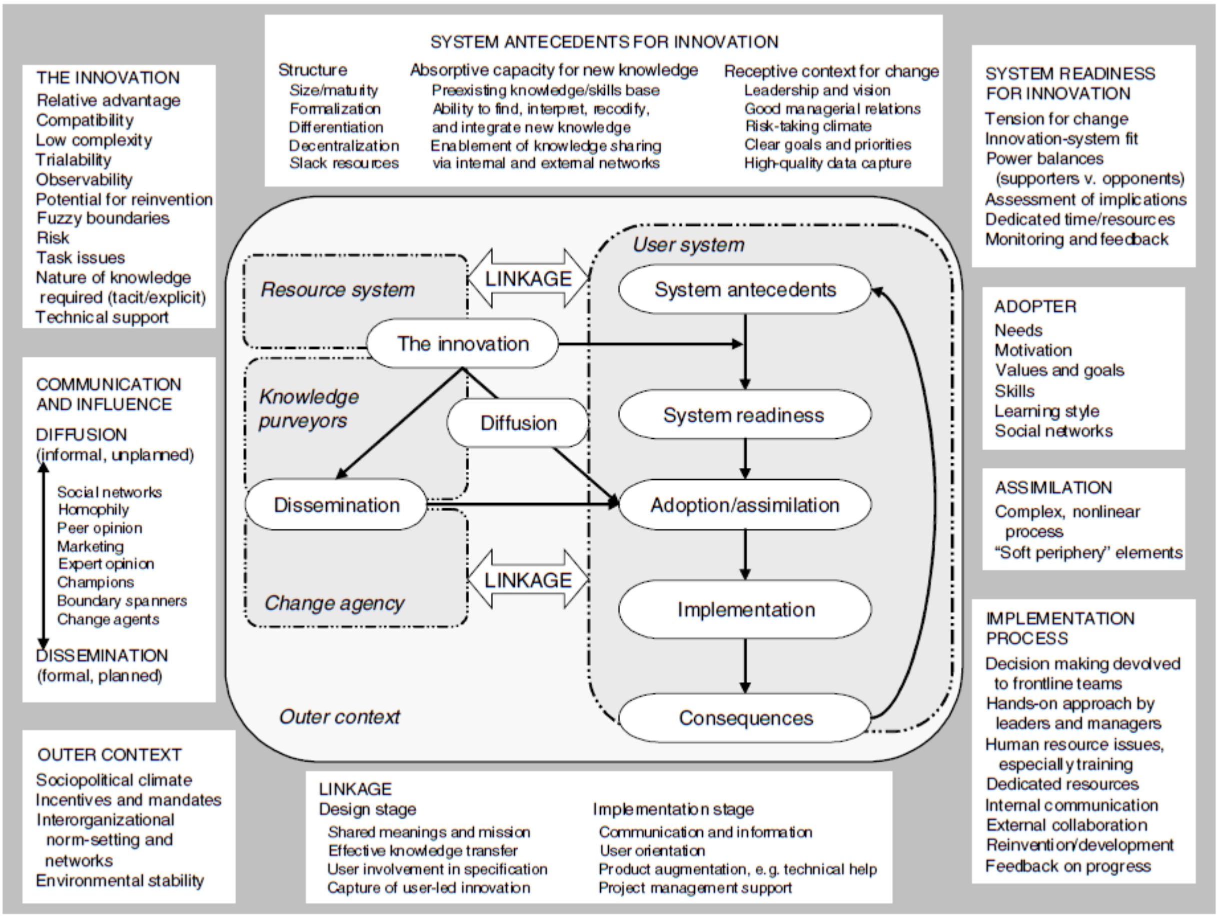

Figure 5.1 Conceptual model of the knowledge-into-action process by Greenhalgh et al. (2004)

Collins (2010a) explained that knowledge can be divided into explicit knowledge and tacit knowledge. Explicit knowledge is easy to codify and document. Explicit knowledge is defined as containing a personal element (Little and Ray, 2005; Pritchard, 2006; Heiberg Engel, 2008; Collins, 2010), while tacit knowledge, according to Polanyi (1962), represents knowledge that is already embedded in a person's cognitive processes. It is intuitive and unarticulated knowledge that cannot be communicated, understood or used without the 'knowing subject'. For example, I know, without consciously thinking, that to tie my shoelaces I move my fingers in a certain way. However, this tacit knowledge can still be communicated and shared (Polanyi, 1962). Tacit and explicit knowledge are not two separate types of knowledge; they are inherently inseparable. There are different debates about the transfer of explicit knowledge and the transfer of tacit knowledge. Some authors suggested that tacit knowledge can be based in explicit knowledge (Grant, 1996; Hansen et al., 1999). Others implied that explicit knowledge could be transferred into tacit knowledge or the other way round (Hansen et al., 1999; Haldin-Herrgard, 2000; Dhanaraj et al., 2004; Stover, 2004). Regardless of the transfer between the two, explicit knowledge can be generated through education and generated through practical experience in the relevant context; while tacit knowledge can only be generated via personal or practical experience. By adopting the knowledge-creation part of the knowledge-into-action frameworks, the fever knowledge framework was created. As mentioned earlier, the knowledge production process in Graham et al.'s 2006 framework had comparable results with the results of this study as the knowledge-generating process was found to be linear. The process started with knowledge inquiry, which, in the fever context, was largely based on education, the Sepsis Six bundle and experience. As in discussed in Section 4.4.1, fever knowledge was grounded in education, although education may not directly influence the outcome of knowledge production. The Sepsis Six bundle played an important role in both fever knowledge and fever management. Both education and the Sepsis Six bundle were considered to be explicit knowledge. Experience was also one of the key factors that contributed to the formation of fever knowledge. Although the relationship between the length of the experience and the production of fever knowledge was not found to be significant, it was revealed that the variety of experience had a significant impact on the generation of fever knowledge. It was found that the greater the variety of experience a person had, the more knowledge about fever that person would gain. Therefore, experience was one of the components that formed the basis of fever knowledge. Interviewee M explained how he thought his fever knowledge was constructed.

> *I think it is probably a combination of things. A lot of these things you do cover when you're in your nursing training; but dealing with somebody who has got a high temperature, that is something that is a common sense thing really that we all have, don't we? (M interviewee)*

Many participants expressed the same thoughts. It was found that at this stage of fever knowledge-generation, more explicit knowledge was involved. The next step of the knowledge-tailoring process, as known as knowledge generation, was the synthesis of the knowledge followed by the final knowledge product. The analysis of the results from this study showed a similar result, as most of the participants believed the experience could enhance their fever knowledge. Take the following excerpts, for example.

> *… but then that's also built upon with years of experience in dealing with actual patients and managing those conditions. (M interviewee)*

Interviewee M illustrated how his fever knowledge gradually built up. Interviewee G also made a similar statement about the development of fever knowledge after his initial nursing education.

> *… which is all scenario learning. So when it does happen in real life, you know, you kind of automatically start doing things. (G interviewee)*

Interestingly, the synthesis of knowledge seemed mostly to derive from the clinical setting and was enhanced by practice. As described in Section 4.4.3, the Sepsis Six bundle was underpinning the fever knowledge and fever management. It is worth noting that intuitiveness was involved in this stage of knowledge formation. It could be concluded that the knowledge-synthesis process was very much driven by clinical experience and the Sepsis Six bundle. Knowledge at this stage was dominated by tacit knowledge, because fever knowledge had been internalised or was considered to be common sense. Take the following quote as an example.

> *Obviously, I know it based on stuff, but looking through it I'm like, 'I don't know.' It feels like my specific knowledge like that has decreased a bit, but practically applying the knowledge is maybe a bit better, if you know what I mean? … I'm just thinking about this myself just now, so I'm just trying to word it. Maybe when I was at University, I knew the facts really well about the renal system and things like that, but then I didn't really know what that meant in context of a patient…. I knew exactly what these things meant, but in terms of looking at a patient and having that information, I wouldn't really have been able to connect it. But now, it's the other way around. I have the patient, I know all the blood results and things like that, but I really can't connect that quite as well to the classroom information. (R interviewee)*

According to interviewee R, it would seem that experience was important while internalizing the knowledge learnt from the education. However, it was difficult for her to explain knowledge gained through experience. This characteristic of knowledge from experience appeared to match the feature of tacit knowledge, which involved practice rather than thinking and was learnt automatically (Polanyi,1958; Smith, 2001; Heiberg Engel, 2008). It is through this synthesis process knowledge is internalised. The final stage of generating the fever knowledge was knowledge production. It was found that knowledge production in fever was used greatly in initial interpretations about fever, which was one of the key elements that would influence the fever management (see Section 4.4.4). As demonstrated in Figure 4.15, initial interpretations about fever were found to be shaped by the clinical environment, clinical routine, the Sepsis Six bundle, fever management and general knowledge about fever.

Figure 5.2 demonstrates the process of fever knowledge creation which is adapted from Graham et al. (2006). To sum up, it was found that considerable fundamental information about fever was provided while the participants were in training and was also learned in practice in the clinical setting (see Sections 4.4.1 and 4.4.2), including knowledge of the Sepsis Six bundle. The clinical routine and administering the Sepsis Six bundle in the clinical environment helped to synthesise and internalise the knowledge from education and experience. Finally, an individual’s fever knowledge was produced. According to the result of this study, the fever knowledge production was highly used in initial interpretation about fever. The decision of fever management heavily depended on initial interpretation about fever. In the first level of knowledge production, which was the knowledge inquiry stage, education and the Sepsis Six bundle were deemed to be explicit knowledge. Whereas during the knowledge synthesis stage, the clinical routine was considered to have elements of tacit knowledge, when most of the participants ‘just knew’ they should do certain managements in a certain way.

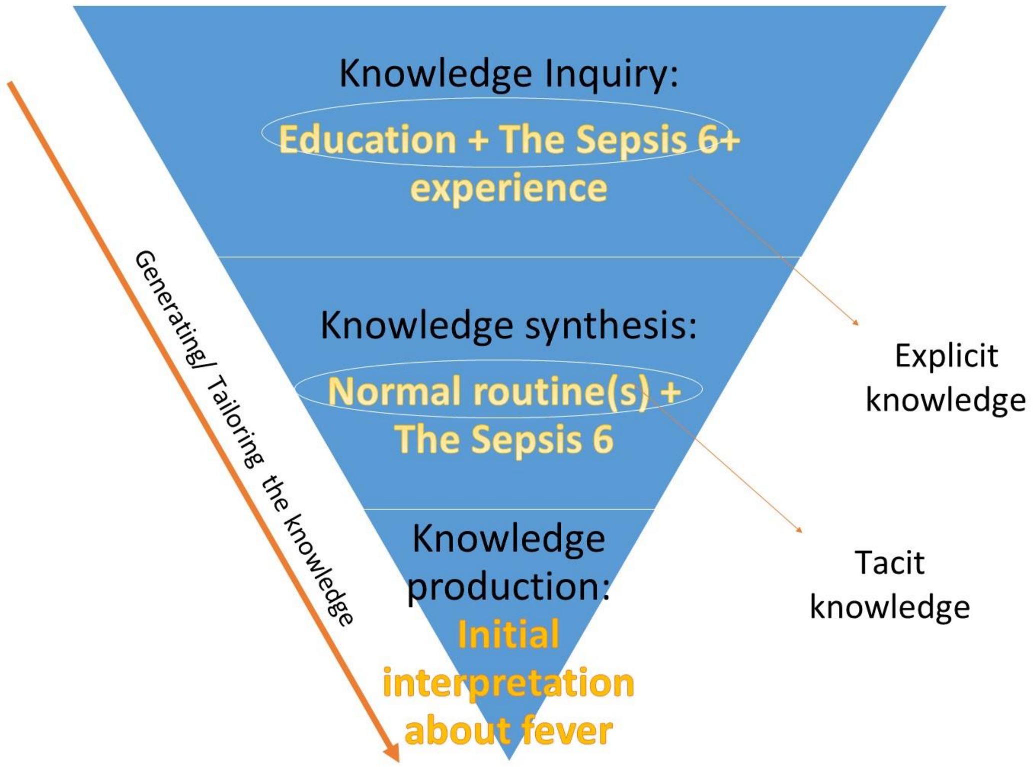

Figure 5.2 The development of the knowledge formation specific in fever based on the synthesis of the data, adapted from Graham et al. (2006). The knowledge production is greatly employed while interpreting fever causes which has considerable influence on fever management.

It was interesting that tacit knowledge was dominant when the generation process was closer to the final knowledge production. In Polanyi's 1962 view of 'tacit knowing', the author demonstrated this using 'expert' thoughts and experiences. In contrast to tacit knowledge, gaining explicit knowledge would require the gaining of skills; while the tacit knowledge was rooted in an individual's mind and therefore it was unnecessary to acquire skills in order to obtain tacit knowledge. The characteristic of the expert especially represented that they usually making their decision according to their tacit knowledge. An expert usually acted or made judgements without explicitly reflecting on the principles or rules involved. The experts worked without having a theoretical basis to their work. They just performed skilfully without deliberation or focused attention (Benner and Tanner, 1987; Benner, 2004; Benner and Tanner, 2009;

Thomas and Kellgren, 2017). It was worth noting that decision making, and the intuition related to tacit knowledge, was raised in the context of knowledge. Moreover, it was found that the context of knowledge was similar within the decision-making framework (see Section 1.3.2). A more detailed explanation of the comparison between the context of knowledge in this study and a decision-making framework will be addressed in Section 5.5.

5.4 Nurses’ knowledge development of fever

From the study results, it appears that the nurses’ knowledge of how they manage fever was not up to date or was over-ruled by their experiences, regardless of whether it was in accordance with the evidence-based best practice. Consequently, those nurses who were unaware of the latest guidelines for managing fever patients did not know what other management options they could possibly provide besides giving paracetamol, which is the most popular management, or providing other antipyretics. Section 5.3 discusses how fever knowledge is formed, and the process is illustrated in Figure 5.2. In order to investigate further how nurses’ experiences with fever overrode the fever knowledge they had gained during training, some theories on knowledge building are discussed below.

The knowledge-building process has been under discussion long before the twenty-first century. Karl Popper, who was regarded as one of the greatest philosophers of science in the twentieth century, first proposed his analysis of this process in (Popper, 1979; Bereiter, 2002). Popper’s theory (1979) states that knowledge is objective, and the existence of knowledge is made up of three interacting worlds. World 1 is the world of physical objects and events (including biological entities), World 2 is the world of mental objects and events, and World 3 is objective knowledge (Popper, 1979). Bereiter (2002) further explored Popper’s three worlds and presented them as the physical (World 1), the subjective (World 2), and the locus of cultural products (World 3). Bereiter found that learning takes place in World 2 where the human brain tries to understand the objects, while knowledge is produced and gained by individuals in World 3. The learning process occurs between World 2 and World 3 (Bereiter, 1994; Bereiter, 2002). Bereiter (1994) suggested that enculturation needed to be considered in order to improve the knowledge that was being collectively created, implying that the knowledge gained by individuals may not be original after the process of knowledge building, e.g. knowledge might only restate something from a textbook and be unable to adjust to a different situation. The findings of this study are similar to this statement. Some of the participants were knowledgeable about fever but did not know how to deal with different types of fever. Instead, they deemed that all types of fever were caused by infection, demonstrating how knowledge building interprets the original knowledge as illustrated by Bereiter (1994). In Question 13 (see Appendix A), 43% of participants thought that only infection could be the cause of fever (Appendix F). A cultural effect could possibly be the reason why nurses' fever management was strongly influenced by their clinical experience. Interviewee C gave an example of how fever was diagnosed in the oncology unit.

> *For us in oncology, I think temperature is one of the key things that we look out for with our observations because of the risk of neutropenic sepsis or just sepsis in general. (C interviewee)*

It seemed as if fever was an indication of sepsis in C's clinical environment. She continued explaining how they would react if there were fever symptoms.

> *I obviously complete the observations that I am doing … whether or not they are showing signs of a focal point for their sepsis. … And I would be looking at their chart to see what antibiotics they were on … and how long they have been on antibiotics for. … We have very few people on paracetamol*

> *and we don't often have a PRN prescription for paracetamol for fever. (C interviewee)*

C gave an example of how they would manage fever in oncology patients. Compared to other units, they rarely gave paracetamol straightway. Instead, they investigated the patient's history of medication with antibiotics first. C mentioned the cultural approach to managing fever when discussing clinical guidance.

> *... there is a neutropenic sepsis protocol … it became sort of a cultural approach to managing fever … is it the only protocol that we rely on? Obviously we've got the Sepsis Six that's underpinning it as well. (C interviewee)*

These excerpts show that participants' fever knowledge was heavily affected by the cultural environment in their unit and how this knowledge could impact the clinical management. This echoes Bereiter's theory that the learning process takes place between World 2 and World 3, when the human brain attempts to understand knowledge through enculturation.

5.4.1 The learning process

It is evident that experience plays a vital role in the knowledge-building process. Experience, including making mistakes and the process of enculturation, provides the basis for learning. The use of existing knowledge, such as knowledge from a textbook, in different contexts may be affected by the learning process in which the knowledge becomes personal. In this chapter, the knowledge processed by individuals is defined as personal knowledge. Learning is heavily involved in the creation of personal knowledge (Eraut, 2000; Eraut, 2004a). The learning process can be either formal or informal (Eraut, 2000; Boud and Middleton, 2003; Eraut, 2004a; Dabbagh and Kitsantas, 2012). Formal learning includes learning at institutions, learning for specific outcomes, learning with instructors/teachers and learning for the award of a qualification. Non-formal learning is defined as 'learning in the absence of explicit knowledge about what was learned' (Reber, 1993). There is no awareness of non-formal learning at the time it takes place, it is spontaneous and unplanned (Eraut, 2000; Eraut, 2004a). Most learning activities embedded in the workplace may be non-formal, e.g. trial and error, observing, reflecting and practising (Eraut, 2004a). Horvath et al. (1996) and Eraut (2000) studied how non-formal learning affects future behaviour (Figure 5.3). In their studies, they discovered that tacit knowledge, which they defined as 'knowledge that had not yet been abstracted from practice', is widely produced in non-formal learning. They found that non-formal learning implicitly links past memories with current experience. Consequently Horvath et al. (1996) and Eraut (2000) further investigated the learning process that is connected to memory and produces tacit knowledge. In their theory, two types of memory were mentioned: episodic memory and semantic memory. Episodic memory is comprised of the specific events that can be explicitly stated or conjured up by individuals. Semantic memory refers to the general world knowledge we have accumulated throughout our lives, and which is a part of long-term memory (Eraut, 2000). Figure 5.3 demonstrates the explanatory model of memory structure and knowledge acquisition pathways created by Horvath et al. (1996) and Eraut (2000). The top of the figure is the source of input to the memory system, and the bottom of the figure illustrates the behavioural consequences of learning. Path A depicts the personal practiced and experienced events that are stored in episodic memory. The knowledge stored in episodic memory is used to structure the public propositional knowledge in semantic memory. Semantic memory directly influences an individual's performance. Path B represents the direct acquisition of generalisable knowledge from other people. It has been observed that Path B is usually employed during reflection upon, and clarification of the meaning of, past experience or the shaping of new Path A knowledge into a broader conceptual structure. Therefore, both Path A and

Path B are often required to perform an action. In a rapid situation, in which Path B might be too abstract to be used without further learning, Path A* would be applied. Eraut (2000) gave an example to explain when Path A* would play a role in non-formal learning. 'An encounter with a new situation fairly similar to some of those previously experienced may lead to rapid recognition through Path A*.' This example resonates with the results of this fever study. In a situation demanding a rapid response, every similar situation that the participant has encountered will seem to be alike. Accordingly, a similar action or performance will be elicited, even when the two situations may not be similar enough for replication to be the best action (Eraut, 2000). According to Eraut (2000), the definition of tacit knowledge is not exactly the same as discussed in Section 1.2.1. Polanyi (1958) described tacit knowledge as the product of automatic, unconscious learning processes that involve practice rather than thinking, which is difficult to articulate, such as recognising a facial expression. Collins (2010b) identified tacit knowledge as a product that is independently realised and assumed to be directly related to reality, whereas Cowan et al. (2000) defined the term 'tacit knowledge' as personal knowledge, which indicated knowledge that was internalised by individuals. In nursing, tacit knowledge is referred to as nurses' intuitions about patients' weel being or deterioration (Josefson, 1988; Leonard and Sensiper, 1998; Herbig et al., 2001; Gourlay, 2004). Eraut's (2000b:119) outlined tacit knowledge as 'knowledge that had not yet been abstracted from practice'. Although the details of tacit knowledge are not the same, similar to most assertions (Leonard and Sensiper, 1998; Argyris, 1999; Torff, 1999; Cowan et al., 2000; Eraut, 2000; Dhanaraj et al., 2004; Collins, 2010), Eraut (2000) suggests that tacit knowledge is difficult to share as knowledge transfer.

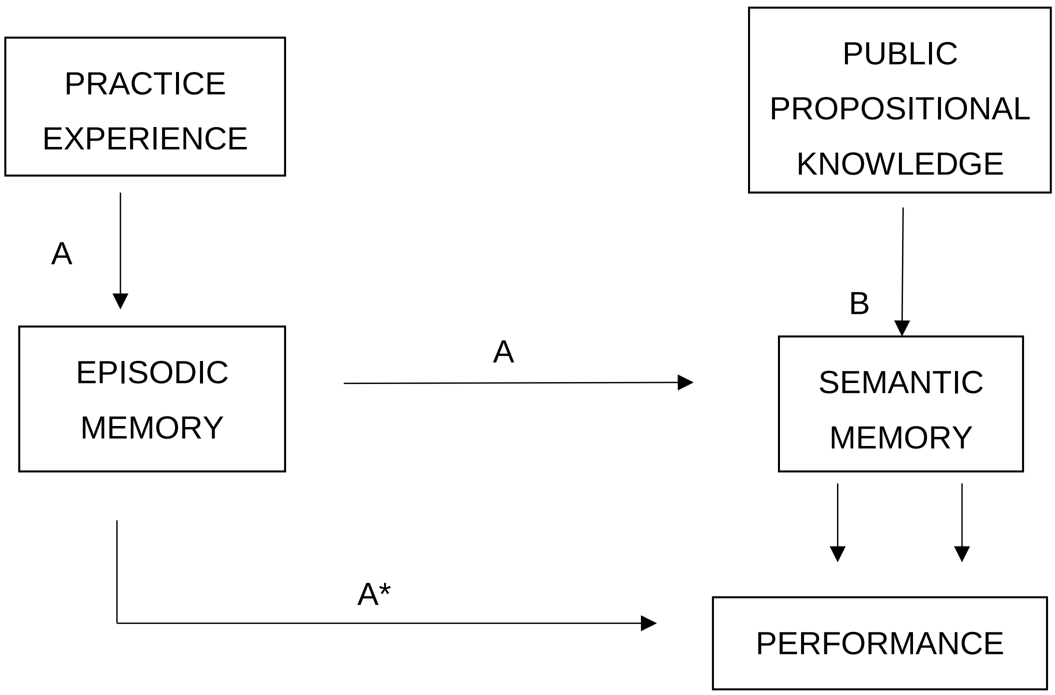

Figure 5.3 Memory structures and knowledge-acquisition pathways in the explanatory model by Horvath et al. (1996) and Eraut (2000).

While tacit knowledge represents the knowledge in practice, explicit knowledge represents knowledge in stated rules. It would seem that there is something in the flow between the practices and stated rules that cannot be fully expressed (Styhre, 2004; Wong et al., 2013a). As a result, the binary distinction of tacit knowledge and explicit knowledge representing the overall knowledge acquisition by individuals remains debateable (Spender, 1996; Styhre, 2004; Bogers et al., 2010)

Interviewees G and R expressed how they felt about fever symptoms.

> *It's usually that the high fever, the pyrexia is an indication that you've something way more serious going on here. Like sepsis or like a very adverse reaction to a drug. (G interviewee)*

> *Lots of patients are pyrexic because of their chest infection … lots of our patients are smokers. Before the operation they*

> *have COPD anyway, and then obviously being intubated is going to make that worse. (R interviewee)*

In their clinical environment, they all considered fever symptoms to be related to certain diseases despite the variety of causes of fever. It is worth noting, however, that the presence of fever symptoms alone could be an indication of a certain disease. It seems that they all followed learning Path A* in the situations described in the extracts above. Those performances were described as routinised. As, as stated by Eraut (2000), 'routinisation starts by following other people, or manuals or checklists or even self-devised procedures'. Interestingly, the routine and checklist (which referred to the Sepsis Six bundle) were two of the themes generated in this study. Interviewee R discussed a scenario in which she followed her colleague's advice while managing a fever.

> *I remember asking a colleague once. Somebody had a fever and they were like, 'Okay. Give them paracetamol.' I said, 'Won't that mask the symptoms?' They said, 'Yes. But they're going to be really uncomfortable. The fever is going to make them feel really uncomfortable, so you should make them feel comfortable by giving them paracetamol.' (R interviewee)*

Interviewee M's statement also offered a case in point.

> *Sometimes patients will have come back from theatre, from a procedure, and they have missed a dose of medication because they've been in theatre. You go, 'Oh, you've got a wee fever, but you've not had your paracetamol.' So, we can give it then. (M interviewee)*

The advice from both of R and M's colleagues seemed to have the same direction, i.e. following the routine. Although R and M were a little uncertain about the advice, they administered the treatment suggested by their colleagues. Routine procedures were also frequently mentioned in this study, especially the guidance of the Sepsis Six bundle. Take the following quotations as examples.

> *People are very practised at what happens. Often, you'll get a crash call with a septic patient, or suspected sepsis patient, arriving in 10 minutes. You know that they're coming in and you're going to do those Sepsis Six things straightaway. (M interviewee)*
>
> *Following the Sepsis Six protocol. (Participant 10, questionnaire)*
>
> *Patients with fever are scored using a verified sepsis tool and referred to hospital if required. (Participant 24, questionnaire)*
>
> *Fever is considered a major indicator of sepsis and national protocol indicates for its timely management. (Participant 19, questionnaire)*

Interviewee C also considered using guidance when managing fever.

> *That sounds like the sepsis protocol is really working. Like underpinning everything related to fever. (Interviewer)*
>
> *It certainly is something that we, you know, flag up quite quickly. So, yes … . (C interviewee)*

For the above participants, clinical guidance was useful and practical when managing patients with fever.

5.4.2 Routinisation to intuition

Routinisation can apply a simple algorithm to a straightforward process. According to Eraut (2000), learning by repetition enables individuals to internalise a routine. The process of performing from routinisation to performing by intuition is an aspect of non-formal learning. For example, when riding a bicycle in busy traffic, the cyclist knows the best way to avoid a traffic jam without further explanation because of their everyday observations. It becomes a reflection of knowing what to do. It was found that in a non-formal learning environment, individuals tend to internalise the routine to abbreviate the procedure of requiring a checklist or another person's aid (Eraut, 2000; Eraut, 2004a; Tsoukas, 2005; Eraut, 2007; Eraut, 2012; Eraut et al., 2012; Moon, 2013). In Carper's ways of knowing, the internalisation and involvement of the clinical culture was also emphasised, for example in personal knowing and social political knowing (Carper, 1978; White, 1995). Routinisation and intuition can both be experientially developed; however, there will be some cases in which an individual will need to make a rapid decision in an unfamiliar situation. The unfamiliar situation, which in the ideal would require path A* to help with the decision-making process, would subsequently develop into less unfamiliar situation. It becomes concerning when Path A* is internalised by an individual through repetition in a similar but different situation. The action becomes taken for granted as the individual no longer needs to think about what they are doing because they have done it so many times before (Eraut, 2000; Eraut, 2004a; Tsoukas, 2005; Eraut, 2007; Eraut, 2012; Eraut et al., 2012; Moon, 2013).Intuition gradually develops through experience. Nevertheless, action without thought should not be a product of routinisation.

Eraut (2004b) conducted a study to research how knowledge transfers from education to the workplace among nurses and midwives. He found that the participants were using certain knowledge to underpin their practices but that they often struggled to explain exactly how the knowledge justified their decisions. The author discovered that once nurses and midwives had a lot of experience in a certain area, they would work by pattern recognition, thus routinising nursing care through Path A* (see Figure 5.3). Moreover, they would no longer refer their routine care back to their scientific knowledge. The results of Eraut's (2004b) study were similar to the dual process theoretical framework of this study (see Figure 1.3), as this study's participants often employed a more S1-oriented decision-making pathway in every fever case. Interviewee G illustrated the intuitiveness of decision making with fever patients.

> *I think it's all intuitive things. (G interviewee)*

As Interviewee G explained what fever management was like in the clinical environment, Interviewee M also gave an example of rapid decision making in fever management.

> *… there were often a lot of things that nurses did without understanding completely about reasons of doing it. Usually, those managements were considered as common sense. (M interviewee)*

From the quote of Interviewee M, common sense resembled knowledge taken for granted, indicating that fever management was primarily performed by intuition. Interviewee G explained this further.

> But, actually, when it does happen, I think you automatically kick in. Your mind automatically kicks into right crisis mode. This is what we need to do. Da, da, da, da, da … and you're doing the very kind of. You do it in *a very systematic way. You do it without thinking. (G interviewee)*

The above extracts specify how clinical routine became intuition and reflection without rational thought. In the nursing profession, the ability to make good clinical judgements is crucial. According to Croskerry and Nimmo (2011), decision making can be either intuitive or rational (Figure 1.3). Often, a decision is made via the collaboration of both intuition and analytic reasoning

(Croskerry, 2005; Paley et al., 2007; Croskerry, 2009; Croskerry and Nimmo, 2011; Evans and Stanovich, 2013). Melin-Johansson et al. (2017) studied the characteristics of intuition among registered nurses in clinical settings through an integrative review. The review showed that intuition in clinical practice was developed on the basis of knowledge and experience caring for patients. In addition, preference for using intuition in nursing improved with experience (Polge, 1995; King and Clark, 2002; Ramezani-Badr et al., 2009; Pretz and Folse, 2011; Melin-Johansson et al., 2017). Although intuition played a leading role in the nurses' decision-making processes, they were generally reluctant to explain their actions as based on intuition because of the criticism they might receive in a hierarchical healthcare structure (Polge, 1995; Rew and Barrow Jr, 2007; Ramezani-Badr et al., 2009).

In the model of skill acquisition by Dreyfus and Dreyfus (1986), the progression from novice to expert is depicted through five levels (Table 5.1). The model supported the widespread use of rapid, intuitive decision making by experts (Dreyfus and Dreyfus, 1986; Benner and Tanner, 1987; Benner, 2004; Benner and Tanner, 2009). Studies have revealed that use of intuition in decision-making processes expands with nurses' experience (Polge, 1995; King and Clark, 2002; Ramezani-Badr et al., 2009; Pretz and Folse, 2011; Melin-Johansson et al., 2017). Although experience is essential for a novice nurse to become an expert, it is not, of course, the only element that makes an expert. According to Benner and Tanner (2009), expert nurses employed 'deliberative rationality' in all clinical situations they encountered, even when an intuitive decision was made (Thomas and Kellgren, 2017). This reinforced the evidence that non-nurses should not apply intuition alone when making decisions. Nurses should integrate both intuition and rationalism when making decisions. They should be alert to their sense of intuition, as it might expand their knowledge and experience, and have consequences for the quality of patient care (Benner and Tanner, 1987; Hamm, 1988; Cert and Wilcockson, 1996;

Lamond and Thompson, 2000; King and Clark, 2002; Bjørk and Hamilton, 2011; Pretz and Folse, 2011; Melin-Johansson et al., 2017). However, it was argued that the skill acquisition model was too philosophical and had limited contribution in clinical practice. Two main arguments were made. Firstly, it was difficult to identify experts, as there were no explicit criteria on the definition of experts. Secondly, avoiding using only intuition only was difficult, as employing intuition was difficult to detect and intuition was generated automatically (Paley, 1996; Cioffi, 1997; Clark, 1998; Ericsson et al., 2007; Gobet and Chassy, 2008; Steinkamp et al., 2008). The debates on skill acquisition model synchronised with the study of this research, which the intuition is generated automatically without notice. Take G’s excerpt for example.

> *But actually when it does happen, I think you automatically kick in. Your mind automatically kicks into, right crisis mode. This is what we need to do. Da, da, da, da, da … and you’re doing the very kind of. You do it in a very systematic way. You do it without thinking. (G interviewee)*

It is clear that intuitive decision-making is subconscious and happens automatically without conscious deliberation. Whether such processes are appropriate or inappropriate with respect to the individual’s expertise is the constant concern. However, what is recognised is that reflection is one of methods to improve the use of intuition (Hall, 2002; Klein, 2015). As fever is a symptom commonly observed in patients, it can be difficult to distinguish who is the expert in fever decision-making and who is not.

Skill Level	Components	Perspective	Decision	Commitment
1.Novice	Context free	None	Analytic	Detached
2.Advanced beginner	Context free and situational	None	Analytic	Detached
3.Competent	Context free and situational	Chosen	Analytic	Detached understanding and deciding; involved outcome
4.Proficient	Context free and situational	Experienced	Analytic	Involved understanding; detached deciding
5.Expert	Context free and situational	Experiences	Intuitive	Involved

Table 5.1 Five Stages of Skill Acquisition by Dreyfus and Dreyfus (1986). Components: These are the elements of the situation that the learner is able to perceive. They can be context free and pertain to general aspects of the skill or situation, they only relate to the specific situation that the learner is meeting. Perspective: As the learner begins to recognise almost innumerable components, he or she must choose which one to focus on. He or she is then taking a perspective. Commitment: This is the degree to which the learner is immersed in the learning situation when it comes to understanding and deciding the outcome of the situation – action pairing.

In this study, however, it was shown that the System 1 pathway was frequently used without engaging System 2 (Figure 1.3) because the participants considered the fever symptoms as common sense and they could be managed through intuition. As a result, antipyretics were used in most of the fever cases. Hence, questions regarding the current clinical fever management and the decision-making process in treating fever patients were raised. Although the nurses tended to rely on System 1 (Figure 1.3) in most fever situations, it was worth noting that System 2 (also referred to as rational thinking) was engaged when a clinical situation was unfamiliar. Since many different clinical conditions can result in fever, the nurse must look for other symptoms before deciding on the best intervention for the patient. Fever management should be person centred. Nevertheless, in this study, it was found that even with a more rational decision-making pathway such as System 2 (Figure 1.3), routinisation was strongly involved, especially use of the Sepsis Six bundle as discussed in Section 7.2.3. However, the Sepsis Six bundle should not, of course, be involved in the care of every fever symptom, even when the evidence suggests that fever symptoms were infection related (Shapiro et al., 2006; Mayr et al., 2010)? The influence of the Sepsis Six bundle is discussed later on in this chapter (see Section 8.9).

5.4.3 Mismatch between evidence-based nursing and routinisation

The nature of routinisation in non-formal learning among nurses involved performing intuitive actions. Nevertheless, it has been debated whether nursing-care knowledge, generated from non-formal learning, can harmonise with evidence-based nursing. In this study, the results demonstrated some apparent disparity between evidence-based nursing and clinical routine, as illustrated in Section 4.3.4.5. It was clear that the clinical routine, such as providing regular paracetamol in the surgical unit and the Sepsis Six bundle, were not designed as guidance to manage fever. Providing regular paracetamol in the surgical unit served to relieve pain, while the Sepsis Six bundle was used to detect and combat sepsis early on. Despite this, this study discovered that when the regular paracetamol provided post-surgery was mistakenly thought to be an antipyretic and was missing, this was considered to be the cause of fever. The paracetamol for pain had taken Path A*, as displayed in Figure 5.3, and had become a routine treatment for fever patients. The routinisation developed into a taken-for-granted reflection, and the participants no longer thought about the rationale of such actions. The same situation was noted during use of the Sepsis Six bundle for fever patients. The Sepsis Six bundle was originally designed to detect sepsis early and manage patients with sepsis accordingly. With the successful implementation of the bundle, nurses became more aware of sepsis (Medical Directorate, 2013; Breen and Rees, 2018; Burke et al., 2019), and of fever as one of the features of sepsis. The results of this study show that the participants linked fever directly to infection and consequently they then connected sepsis to fever. Eventually, every case of fever was diagnosed as being caused by sepsis, even when the cause of fever was not an infection. Again, nurses treating fever patients with sepsis had taken Path A* (Figure 5.3) and their knowledge had become a taken-for-granted thought. As a result, the Sepsis Six bundle would often be immediately employed for patients with fever. The connection between managing fever and applying the Sepsis Six bundle or using paracetamol regularly to control pain seemed to be associated with rapid decision-making as well as Path A*. It would seem that Path A* and S1 shared similar characteristics. The Repetitive routinisation and performing intuitively resulted in automatic actions without thought However, Path A* is concentrating on the individual's knowledge selection process which could subsequently contribute to the S1 decision-making process. Chiu (2012) stated that 63% of clinicians tend to automatically reduce fever. Moreover, the severity of illness was not necessarily associated with antipyretics administration (Mohr et al., 2011). This indicated that clinicians tends to provide antipyretics, even when the patient was not suffering from severe illness. In the following excerpt, Interviewee G describes an example of fever management.

We do that and, obviously, we assess their … their airways,

> *breathing, circulation, disability. We do all that as well too and I think it’s really hard to describe (fever management), because I think you do it automatically … . (G, interviewee)*
>
> *So, when you were saying about automatic response, what do you mean by that? (Interviewer)*
>
> *I think your automatic responses are kind of. You know, you learn what to do in theory, what to do when a person is unwell … but actually when it does happen, I think you automatically kick in. Your mind automatically kicks into, right crisis mode. This is what we need to do. Da, da, da, da, da … and you’re doing the very kind of. You do it in a very systematic way. You do it without thinking. (G interviewee)*

Interviewee G explained the automatic process used when dealing with fever patients. Interestingly, he also pointed out that the automatic reflection originated from tacit knowledge that could not be described. Likewise, Interviewee A also stated that the fever management was an automatic response. When asked about how she decided which intervention to use, she replied as follows.

> *We automatically just do that … it is just done in the same way. (A interviewee)*

The above quotes display the intuitive characteristics of fever management. Although the routinisation and intuitiveness were not necessarily inappropriate, there was the danger that an individual’s instinctive reflection and interpretation of information could be biased (Eraut, 2004a; Eraut, 2007). Established articles have revealed that intuition is characterised by intense confidence in the intuitive feeling. In other words, an intuitive judgement is made based on feelings of rightness or confidence (Agor, 1986; Shirley and Langan-Fox, 1996; Evans, 2010; Glöckner and Witteman, 2010; Klein, 2017).

Thus, what was the reason that intuition often dominated the decision-making in fever management? According to Kahneman and Egan (2011: 110), 'S1 is highly adept in one form of thinking - it automatically and effortlessly identifies causal connections between events, sometimes even when the connection is spurious'. Much evidence has demonstrated that S2 is normally in a comfortable low-effort mode, while S1 operates automatically and continuously. S2 is mobilised when S1 runs into difficulty and cannot offer a response. In this case, a more detailed and analytical decision-making process is operating - the S2 pathway (Tversky and Kahneman, 1974; Tversky and Kahneman, 1978; Kahneman and Egan, 2011). Humans have the ability to do things with little effort. Therefore, when dealing with familiar yet different situations in the real world, our S1 is prone to act through experiential learning. Accordingly, our intuitive judgement is limited to similar historical cases, even when presented with a new dispute (Tversky and Kahneman, 1974; Tversky and Kahneman, 1978; Evans, 2010; Kahneman and Egan, 2011). Only harmful consequences could reduce the actions of S1, resulting in a more engaged S2 (Evans, 2003; Evans, 2010; Kahneman and Egan, 2011). This resonates with the management of fever because over treating fever is seldom considered harmful. Despite the side effects of pharmacological antipyretics, the negative impacts of over treating fever are mostly chronic or indirect. A more in-depth discussion about the consequences of over treating fever is presented in Section 5.9.

Another reason for fever management to be primarily led by intuition could be the participants' confidence when managing fever. In this study, over 80% of the participants believed that controlling fever could reduce patients' hospital stays as well as their mortality rates (see Section 4.3.3). Moreover, participants were confident in their beliefs, as less than 10% of participants selected 'not sure' to the two questions on this topic (Questions 28 and 29). Interviewee A articulated confidence in her fever knowledge and management in the following quote.

> *I am trained pretty highly, actually … I have never really come across anything (fever management) where I have thought, 'No—'. (A interviewee)*

Interviewee C stated the same.

> *So, you are talking about. You think that you're actually quite confident with what you do dealing with fever when you are on your shift, but when you look back on the questionnaire you feel like maybe you lack some of the knowledge? (Interviewer)*
>
> *Yes, horrified. Yes … even in my current post. I haven't felt the need to go and look it up … yes, never even questioned it. (C interviewee)*

Interviewee C was confident in her fever knowledge and management before participating in the study, but after completing the questionnaire she felt uncertain. It seemed as if overconfidence impeded the participants' ability to perform rational decision making for fever patients. This harmonised with the results of studies about intuition. Established articles have stated that confidence is strongly associated with intuitive judgement. According to the scientific evidence, people are overconfident when making decisions in most scenarios. Consequently, they are prone to have high confidence by ignoring unknown or unobserved situations. In a more System-1-oriented judgement, people are likely to have high confidence (Thompson and Dowding, 2002; Thompson and Dowding, 2009; Evans, 2010; Kahneman and Egan, 2011). Pretz and Folse (2011) conducted a study to measure nurses' preferences towards using intuitive judgement. They found that the more confidence the nurses had, the more likely that intuition would be employed in the decision-making process. Moreover, confidence came with experience. Therefore, the more experienced a nurse was implied that they had more confidence. As well as confidence, over-optimism has also been shown to have a significant correlation with intuition. It was discovered that people tend to create plans and forecasts that are 'unrealistically close to best-case scenarios' (Kahneman and Egan, 2011: 250). They have a tendency to overestimate benefits rather than search for mistakes and miscalculations (Kahneman and Frederick, 2002; Kahneman and Egan, 2011). It appears that confidence and optimism are strongly related to intuitive judgement. In addition, confidence was found to have significant correlation with total knowledge score ($p \leqq 0.05$, see Figure 4.24). Yet, the correlation remained negative, which indicated that participants with higher total knowledge score in fever might have lower confidence than participants who had lower total knowledge score. This synchronised with the results of this study, where confidence, intuition and common sense were the three key elements which contributed to the disparity between fever knowledge and fever management.

In this study, routinisation in fever management inappropriately developed into intuition without further analytical reasoning. As a result, a mismatch between evidence-based nursing and the participants' fever knowledge and management was observed. As illustrated in Figure 7.8, three factors were discovered to contribute to the mismatch: confidence, common sense and intuition. From the results, it was determined that both common sense and confidence triggered intuition. The participants were asked whether they were aware of the updated information on fever management, and whether they could identify the gap between the evidence and their knowledge. The following quotations display some of the participants' views on managing fever.

> *I have been under the impression and the guideline states that paracetamol should not be used to reduce temperature but for pain, but a lot of clinicians are still telling patients to get the temp down. I was under the impression that it was the body's*

> *response to kill the infection and if we took the temp down the infection could last longer. It would be good to have guidelines that we all followed. (Participant 13, questionnaire)*

> *I know that there is literature around the fact that when patients have a temperature, that's actually quite a good thing because it's dealing with the infection that's going on. Having a temperature can cause the body to produce more leucocytes and to be able to help deal with the infection. By taking the temperature down, you are stopping that automatic response. The body has to go, 'There's something not right here, do this to make it better.' The body has got its own … I suppose it is doing it together, really helping. (M interviewee)*

> *There is debate as whether to symptomatically treat a rigor by adding extra blankets for patient comfort or to remove blankets and/or apply external cooling which would possibly prolong rigor and patient discomfort. (Participant 32, questionnaire)*

The participants demonstrated an awareness of the disadvantages of managing fever. However, they also affirmed that in clinical practice, clinicians instinctively tended to intervene to control body temperature. One of the participants expressed his feelings about this form of early fever intervention.

> *I think that we intervene too quickly in the hospital environment. (Participant 15, questionnaire)*

Although the uncertainty of the participants' fever knowledge was noted, none of the participants showed the awareness of the gap between recent evidence and their own practice or current clinical practice.

Problems which occur during practice of the knowledge should be identified and discussed. It seems that the process of identifying the real problem while utilising the knowledge is part of enculturation, as this process will eventually influence how the individual absorbs the knowledge. Trial and error can help with problem-centred learning, which is also emphasised in the knowledge-building theory and learning process framework. However, as discussed at the beginning of this chapter, even when fever management was inappropriately provided, the side effects of over treating fever were rarely observed. This could be because the side effects of over treating fever were not obvious or acute enough to be detected. In contrast, the consequences of not treating fever were emphasised as it might develop into sepsis. This fear regarding fever was noted in this study as well as in a lot of established research (Poirier et al., 2010; Greensmith, 2013; Purssell and Collin, 2016). It seemed that nurses were initially afraid of fever, and the subsequent fear that it might indicate sepsis reinforced their concerns. Interviewee G expressed his anxiety in the following quote.

> *Obviously, I know, like, if someone has a high temperature, it can cause lots of complications. It’s not good, or it’s a sign of infection. … You know, people can die in delay from sepsis and from things like neuroleptic syndrome and stuff like that ... . (G interviewee)*

From Interviewee G’s point of view, fever was directly connected to infection and sepsis. Delayed sepsis treatment would result in a worse outcome for the patient, so fever must be managed immediately. This demonstrated the presence of fever fear in the minds of many nurses. As a result, when making a decision for patients with fever in an uncertain situation, they would be more likely to over treat fever because fever phobia outweighed the side effects of overtreatment. Accordingly, most of the nurses would not risk not treating fever.

5.5 Independent professional judgement

One of the questions in the study was about how participants chose their fever management strategies. Participants chose how to manage fever mainly by using their independent professional judgement. As stated in Section 4.3.4 (Figure 4.10), approximately 50% of the participants used their independent professional judgement when making a decision on how to manage a feverish patient. Approximately 15% of the participants made their decisions depending on medical directions, while almost 15% of the participants made their decisions according to the national guidelines. The use of independent professional judgement was also a theme demonstrated in the qualitative results which revealed that participants relied heavily on their professional nursing judgement. Consequently, the study further investigated individuals' independent professional nursing judgements. As noted in Section 5.4.1, although a mismatch between fever knowledge and fever management existed, this relationship was not significant. Participants believed that knowledge was one of the crucial elements in the decision-making process. Interviewee M made the following statement while discussing what elements might underpin their decision-making process.

> *From the very basic, one of the very first things that you learn when you're training is that these are the normal temperature ranges that you're looking for. (M interviewee)*

As illustrated by M, the knowledge of fever was the first thing he would comment on while making a decision for patients with fever. Likewise, Interviewee G also made comments about the decision-making process.

> *I think it comes from our educational background. Because I think, like, there's more pushing us doing more training on it … and it's something I've done. I've found really useful. So I think its thinking about what I've learned in my training. Some of it*

> *is knowing the patient as well. (G interviewee)*

It is worth noting that 'knowing the patient' indicated the individual's experience in caring for patients. Therefore, after a few more words about the origin of their decision, the interviewer attempted to sum up the participant's thoughts about the decision-making process.

> *I guess like your knowledge and decision-making process comes from lots of training and your educational background. (Interviewer)*
>
> *Yes, and other factors and experiences as well … . (G interviewee)*

Interviewee G asserted that education and training, which build up an individual's fever knowledge, and the participant's experience, had a great impact on decision making. The results of other interviews revealed the same themes. Fever knowledge and clinical experience about fever were themed, especially in the decision-making process. Another element that played a key role was the Sepsis Six bundle. As demonstrated in Section 7.2.3, the Sepsis Six bundle affected the participant's fever knowledge and fever management enormously. The bundle was embedded in everything that was related to fever and its management. Therefore, according to the results of this study, it would seem that the decision-making process, which the majority of participants depended on for their independent nursing judgement, was influenced by three components: the participant's knowledge about fever, their experience of caring for a patient with fever and the guidelines of the Sepsis Six bundle. Those three elements also formed the generation of knowledge in fever (Figure 5.2). Interestingly, the result of this study showed that knowledge about fever and the Sepsis Six bundle were considered to be dominated by explicit knowledge, while the experience of caring for a patient with fever contained more tacit knowledge (Section 5.3). The knowledge of fever was then employed in the decision-making process. In addition, the concept of knowledge production of fever and the preference for decision-making had identical contexts within the decision-making framework, as reviewed in Chapter 1.

5.6 Dual process theory

The different types of knowledge included in the knowledge-creation framework, and the result of elements shown in independent professional judgement, had many similarities with the decision-making framework, especially the dual process theory, put forward by Croskerry (2005) in the healthcare setting. This theory has two distinctive modes of thinking. The first, known as intuitive reasoning, is also known as S1. S1 is a fast, impulsive, reflexive and multi-channelled mode of thinking, which is prone to errors. The second mode, analytical reasoning, also known as S2, is slow, explicit, deliberate, purposeful, single-channelled and generally more reliable. The major characteristics of each mode are displayed in Table 5.2. Despite the contrasting natures of S1 and S2, it has been found that S2 plays a more decisive role in the dual process decision-making system. Acting as a default system derived from S1, S2 can override or inhibit S1 (Evans, 2003; Evans, 2009; Evans and Stanovich, 2013). In other words, S1 is supervised by S2, as when S1 is not supported by S2, errors in decision making are likely to occur (Croskerry and Nimmo, 2011). Although S1 and S2 appear to work together, they do not necessarily work at the same time (Evans, 2003; Croskerry, 2009; Chinn and Kramer, 2013). Figure 4.5 demonstrated how the dual process theory operates as a clinician makes a medical diagnosis. The process flows from left to right. Patients are initially presented to a clinician with signs and symptoms of disease. If these symptoms were recognised at the outset, there would be a strong likelihood that the intuitive mode (S1 processes) would be engaged and a very rapid decision would be made. In contrast, if none of the patterns of the symptoms were recognised, the analytical mode (S 2 processes) would be engaged and a slower, more systematic effort would be needed to determine the diagnosis. There are several operating characteristics of the model. First, repeated presentations to the analytical mode will eventually result in the pattern being recognised and default to the intuitive mode will occur. This is the process that occurs as expertise develops. Second, the analytical mode can often override the intuitive mode. If the analytical mode deduces that the intuitive mode may be mistaken about something, for example, the first impression was wrong or an issue needs deeper consideration, an executive override may occur. Despite the executive override, the intuitive mode could also override the analytical mode. Intuition override could result in an irrational act, which is represented by the dysrationalia override (Croskerry, 2005; Croskerry, 2009; Croskerry and Nimmo, 2011). The dotted blue line showed that S1 and 2 could be toggled back and forth. It was emphasised that intuitiveness and rationalism could override each other (Croskerry, 2005; Croskerry, 2009; Evans, 2010; Bjørk and Hamilton, 2011; Croskerry and Nimmo, 2011). The oscillation of the systems was aiming to produce a well-calibrated response. It was noted that the decision-making process of an individual was complicated.

Characteristic	**System 1**	**System 2**
Reasoning style	Intuitive	Analytical
	Heuristic	Normative
	Associative	Deductive
	Concrete	Abstract
Awareness	Low	High
Verbal behaviour	None to minimal	Yes
Prototypical	Yes	No, based on sets
Action	Reflexive, skilled	Deliberate, rule-based
Automaticity	High	Low

Speed	Fast	Slow
Channels	Multiple, parallel	Single, linear
Propensities	Causal	Statistical
Effort	Minimal	Considerable
Cost	Low	High
Vulnerability to bias	Yes	Less so
Reliability	Low, variable	High, consistent
Errors	Common	Few
Affective valence	Often	Rarely
Predictive power	Low	High
Hard-wired	Maybe	No
Scientific rigour	Low	High
Context	Specific	General
Context importance	High	Low

Table 5.2 Major characteristics of type 1 and type 2 decision-making processes (Croskerry and Nimmo, 2011)

As shown in Sections 5.3 and 5.4, intuition commonly played a role in fever knowledge and fever management. Despite an automatic response when managing fever patients, there were some situations where participants would think more analytically. The following quote by Interviewee G demonstrates the process of making an analytical decision during fever management.

> *That you start making decisions when you're trying to think and a judgement about what is causing this. What is the root cause of this? It could be, do they have a history of misusing substances. If you know that yes, there is a high risk of that, you might be thinking, god, have they taken something. … Or if this person is at risk of infection from what we know of their*

recent medical history. (G interviewee)

As a result, the dual process decision-making framework was adopted and used as a reference point for the findings of this study. In Section 5.4. it was mentioned that independent professional judgement for fever management included three major components: knowledge about fever, experience in dealing with fever and the Sepsis Six bundle. Usually, after the presentation of a feverish patient, a nurse would try to find knowledge, which was built on the knowledge product in Figure 5.2, relevant to the patient's symptoms. If the information from the patient's presentation was recognised, then the decision-making process would go through S1. As S1 was multi-channelled and intuitive, the management of the patient would be done intuitively and rapidly. On the other hand, if the presentation of fever and other related symptoms were not recognised in the knowledge base, then the decision-making process would go through S2 which takes a more rational approach. The complicated process of S2 decision-making would take clinical routine and the side effects of fever into consideration, as mentioned in Section 4.4.4. As previously discussed, factors that have an impact on fever management include initial interpretations about fever, fever phobia, the Sepsis Six bundle and the clinical routine of 38°C. The initial interpretations about fever and the Sepsis Six bundle were contained in the development of the knowledge formation. Although clinical routine does not have a direct relationship with fever management, it does influence those factors that are directly associated with fever management (see Figure 4.17. for the details of factors influencing fever management). Therefore, after taking a rational route of decision making, the decision-making process would take clinical routine and the side effects of fever into account and a decision would be made. It was noted that repetition of S2 would eventually result in the pattern being recognised. Essentially, this is the process that occurs as expertise develops. Figure 5.4 shows the dual process theory of decision making in the context of fever. If fever was recognised from the presentation, S1 would be engaged. Alternatively, if fever was not recognised from the presentation, then S2 would be launched. However, there would be concerns about the influence of intuition. Intuition would direct the decision making process with the S1 system. Even in a scenario that should employ S2, S2 could be overridden by S1. The process of S1 taking over from S2 also occurred when the individual was confident about the management of unrecognised patterns. This process of S1 overriding S2 is known as confidence override. On the other hand, in situations where the fever pattern was recognised, the individual might not use S1 but use S2 instead. Croskerry (2009) discussed how confidence can influence management and decision making. An individual with insufficient experience of fever patterns might be overconfident that a particular pattern is the one that they recognise. Ultimately, overconfidence can lead to errors in fever management (Berner and Graber, 2008; Croskerry and Norman, 2008). Confidence was shown to have a direct but negative relationship with fever knowledge. It was also found to be associated with a lack of critical thinking. The discussion from different literature reviews echoes the results of this study showing that confidence is a crucial element in the decision-making process, which moves back and forth between the intuition and the analytic modes.

In practice, if a particular fever management strategy was being administered then there could be four situations with two possible outcomes. First, the management was correct and the patient recovered. Second, the management was wrong but the patient still recovered. Third the management was correct but the patient deteriorated, and finally, the management was wrong and the patient deteriorated. In this last situation, nurses would once again review the analytical decision-making process, especially their thoughts about the clinical routine and the side-effects of fever. Take the following quote as an example.

> *Sometimes patients will have come back from theatre, from a procedure, and they have missed a dose of medication because they’ve been in theatre. You go ‘Oh, you’ve got a wee*

> *fever, but you’ve not had your paracetamol.’ … So we can give it then. (M interviewee)*

It seems that the participant considered not having paracetamol as the primary reason for patients to develop pyrexia. In the surgical unit, paracetamol was often given routinely to control the pain after surgery. Interviewee M’s comments show that when he was in the surgical unit, he immediately thought that a patient developed a fever because they had missed a dose of paracetamol. Although paracetamol was one of the antipyretics that was commonly used, the reason for providing it routinely in this case was to control pain not body temperature. However, not taking paracetamol may not be the cause of fever. The above excerpt demonstrated that if the fever of a patient was not subsided, the participant would relate back to the clinical routine first. Beside clinical routine, fever phobia was another issue underlined in the results. The misunderstanding and reinforcement of the side effects of fever was the main factor that influenced participants’ decisions on managing fever. Accordingly, if a patient deteriorated, participants would look back over the decision-making process and start from the analytical route of considering the clinical routine and side effects of fever.

The following scenario is given as an example of the decision-making process. A patient was found to have a fever of 38°C. However, beside fever, none of the other symptoms were recognised, for example, arrhythmia. Therefore, S2 of the dual theory process would be used to reach a decision on the best management. The analytical route would then go through the clinical routine and the side-effects of fever. The Sepsis Six bundle would be likely to be considered as a clinical routine, which may reinforce fever phobia as discussed earlier (see Section 4.4.3). The next step would be critical thinking and at this step it might be thought that the fever was caused by an infection. Therefore, the outcome of the decision making-process would be implementation of fever management that involves antipyretics and antibiotics.

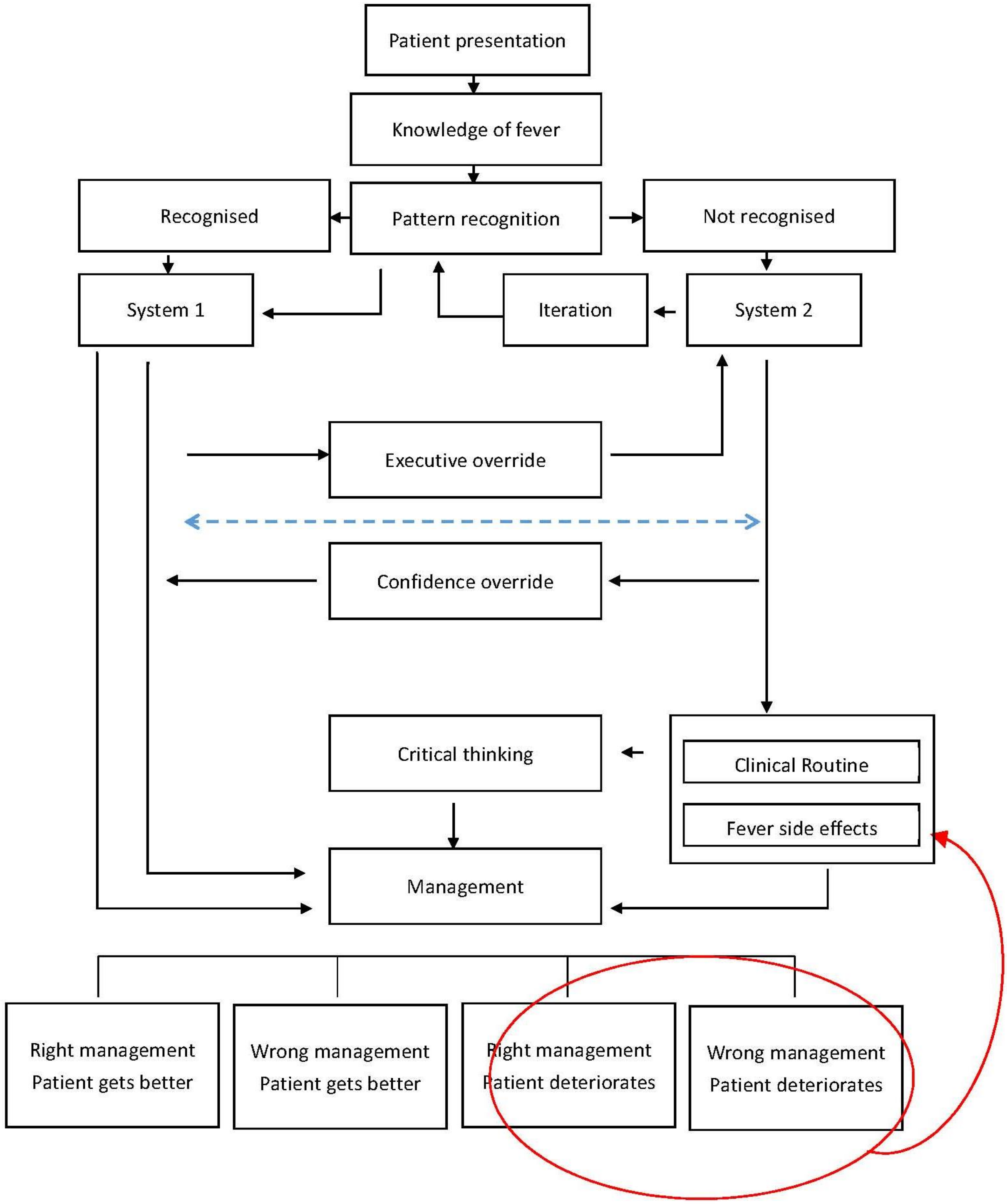

Figure 5.4 The dual process theory of decision making in the context of fever adapted from Croskerry (2005) (Croskerry and Nimmo, 2011).

5.7 The 'Bandwagon' effect

Besides the effect of knowledge, the 'Bandwagon' effect might be one of the reasons that contributes to the gap between the latest scientific evidence and fever management. 'Bandwagon' is a psychological phenomenon whereby people do something primarily based on the information they receive from others. The 'Bandwagon' characteristic is that people initially do, or believe, what they think the majority of other people do, regardless of their own thoughts, which they may ignore or override (Leibenstein, 1950; Asch, 1955; Hobbs, 1992; DuFour, 2007; Kastanakis and Balabanis, 2012). The 'Bandwagon' effect is mostly applied in politics or used to explain consumer behaviour (Cohen and Rothschild, 1979; Mehrabian, 1998; Kastanakis and Balabanis, 2012). For example, Mehrabian's (1998) study showed that 6% of participants will change their votes from their preferred candidate to the likely winner based on the results of pre-election polls. The rationale for 'Bandwagon' effect was further investigated. The theory was that since many other people were doing the same thing, taking a similar action must be good, or at least acceptable (Leibenstein, 1950; Asch, 1955; Hobbs, 1992; DuFour, 2007; Kastanakis and Balabanis, 2012).

The 'Bandwagon' effect has been identified in medicine. Cohen and Rothschild (1979) and Rikkers (2002) reported the 'Bandwagon' effect occurring, especially in the use of new treatments and technologies. Besides occurring in medicine, the 'Bandwagon' effect was also identified in healthcare, when looking to implement policies or change current clinical practice (Malvey et al., 2000; McMillan and Hyzy, 2007; Žvanut et al., 2011). There may be many reasons for this, such as needing to apply a policy, time-management issues, or pressure from patients (Malvey et al., 2000; Rikkers, 2002). In this study, 'Bandwagon' effect seemed to be identified. R described her experience in managing fever.

> *Yes, a mixture of experience and…discussing with my colleagues. (R-interviewee)*

R stated that a part of her fever management approach often came from discussion with colleagues. A scenario was illustrated,

> *Yes. I agree. Like you say, if someone is on paracetamol, it's going to mask it and things like that. I remember asking a colleague once. Somebody had a fever and they were like, 'Okay. Give them paracetamol.' I said, 'Won't that mask the symptoms?' They said, 'Yes. But they're going to be really uncomfortable. The fever is going to make them feel really uncomfortable, so you should make them feel comfortable by giving them paracetamol.' (R-interviewee)*

As R described, although having some doubts about providing paracetamol she decided to follow the suggestions from her colleagues. Another example given by participant 13 was demonstrated as follows.

> *I have been under the impression and the guidelines state that paracetamol should not be used to reduce temperature but for pain, but a lot of clinicians are still telling patients to get the temp down. I was under the impression that it was the body's response to kill the infection and if we took the temp down the infection could last longer. It would be good to have guidelines that we all followed… .(Participant 13, questionnaire)*

It would seem that participant 13 hesitated, due to having a different opinion on fever management from her colleagues. The above excerpts from both R and participant 13 demonstrated the 'Bandwagon' effect in nursing care, where they had both taken their colleagues' advice into consideration, even when the advice conflicted with their thoughts. Moreover, participant 13 emphasised the need to have guidelines that everyone could follow. However, nursing care is susceptible to both social and scientific determinants. Therefore, providing care for patients should be person-centred. From participant 13’s comment, it would seem that having standardised care would be ideal for clinicians. The same suggestion was raised by participant 21.

> *It seems very individually based and I think there is a lack of standardisation around local and national practice. (participant 21, questionnaire)*

In such a person-centred care profession, nurses still preferred standardised care. Perhaps as mentioned in many articles, providing healthcare can be stressful (Cohen and Rothschild, 1979; Malvey et al., 2000; McMillan and Hyzy, 2007). In addition, people feel more confident when following others’ performance, which was implied as the rationale for ‘Bandwagon’ effect in healthcare settings (Malvey et al., 2000; Rikkers, 2002; McMillan and Hyzy, 2007; Žvanut et al., 2011; Kastanakis and Balabanis, 2012). This resonated with the results of this study. Confidence was one of the key things found to be related to the mismatch between fever knowledge and fever management. The ‘Bandwagon’ effect could also explain the reason for engaging the Sepsis Six bundle in every fever symptom situation. It would seem that without the standardisation of fever management, participants seek to find a guidance that everyone can follow. In this case, the Sepsis Six bundle was chosen as one of the criteria was related to fever.

However, ‘Bandwagon’ effect might not be beneficial in a healthcare setting, where person-centred care should be provided to patients. Rikkers (2002) suggested ‘Bandwagon’s should be avoided in a healthcare setting. In order to minimise the this, it is suggested that two key components should be used while providing care, “(1) basing clinical decisions on the best available evidence and (2) developing and encouraging independent, critical thinking in ourselves” (Rikkers, 2002: 791). This suggestion echoes the findings of this study, where one of the elements that contributed to the mismatch between fever knowledge and fever management was a lack of critical thinking (see Section 7.2.6), as the findings of this study demonstrated the participants did not have sufficient knowledge about fever and the majority of participants used their independent nursing judgement, intuitively based, to manage fever.

5.8 Influence of the Sepsis Six bundle

The Sepsis Six bundle was introduced in the UK in 2006. It was designed to help clinicians detect and intercept sepsis at an early stage (Daniels et al., 2011; Singer et al., 2016). The bundle consists of a screening tool for sepsis management as well as sepsis interventions. The assessment involves the observation of vital signs, blood cultures and urine output, while the interventions include providing oxygen and intravenous antibiotics (as in Section 2.4). Use of the Sepsis Six bundle was linked to a 50% reduction in mortality and a decreased length of stay in hospitals and critical-care units (Daniels et al., 2011; Hutcheson et al., 2012; McGregor, 2014). According to the College of Emergency Medicine (2012), a national audit of practice in 4,500 cases from 160 hospitals across the UK, reported that the implementation rates of individual components of the Sepsis Six bundle were above 40%. A similar audit was conducted 2 years later by the College of Emergency Medicine (2014) and revealed that there was a 5% increase in the adherence rate of individual components in the bundle. Among all the individual interventions in the bundle, the provision of antibiotics had the highest administration rate at 94%, while the measurement of urine output had the lowest at 38% (College of Emergency Medicine, 2014). In Scotland, the compliance rate of the Sepsis Six bundle was over 50% in 2015. However, the antibiotic administration rate was about 90% (Ismail et al., 2015). The Sepsis Six bundle was considered to have had noticeable improvement in the compliance rate, and most published studies in the UK displayed a compliance rate of over 70% (Daniels et al., 2011; Bentley et al., 2016; Burke et al., 2019).

With the successful implementation of the Sepsis Six bundle, nurses had become more prone to link fever with sepsis, whilst not recognising non-septic causes (Medical Directorate, 2013; Breen and Rees, 2018; Burke et al., 2019).

Although there are studies analysing the compliance of the Sepsis Six bundle among nurses treating septic patients, there are no published reports on the misuse of the bundle (i.e. conducting the Sepsis Six when the patient was not septic). Early administration of antibiotics, one of the interventions listed in the bundle, is the intervention with the highest compliance rate. Even when the compliance rate of the Sepsis Six bundle was only 50%, the compliance rate of administering antibiotics reached almost 90% (Daniels et al., 2011; College of Emergency Medicine, 2014; Ismail et al., 2015; Bentley et al., 2016; Burke et al., 2019). This matched the results of this study, in which the participants related fever to infection, and, since infection has a strong association with sepsis, many would immediately connect fever to sepsis and the Sepsis Six bundle. When asked about fever management Participant 76 answered as follows.

> *Following sepsis 6 protocol. (Participant 76, questionnaire)*

Participant 17 had the same thought, as well.

> *Patients with pyrexia would be considered for sepsis 6 protocol … . (Participant 17, questionnaire)*

Accordingly, the most efficient way to treat sepsis is through the early administration of antibiotics. Therefore, some participants deemed antibiotics as the treatment for fever. The following quote demonstrates that antibiotics were considered to be an intervention for fever, perhaps even the primary intervention.

> *Following the Surviving Sepsis Campaign and national roll-out of the Sepsis Six, there is greater emphasis on sepsis as a*

> *syndrome, than of fever as a numerical marker of illness. In considering the available evidence for administration of antipyretics in sepsis, I always consider these as second-line therapies as there is much better evidence for the association of administering antibiotics and fluids with improving morbidity and mortality—whereas lowering temperature helps relieve the distressing effects of pyrexia and makes the patient generally feel 'better'. (Participant 159, questionnaire)*

Interviewee C also stated her fever management was as follows.

> *Tepid sponging, removing layers, cold fan, paracetamol, ibuprofen if they are allowed it. … But obviously antibiotics are assisting in there as well … . (C interviewee)*

Likewise, Interviewee R and Participant 106 discussed their fever management.

> *We started him on, I think it was Co-amoxiclav (a type of antibiotics), before any of the samples had been sent away. Before we knew what was going on, we started Co-amoxiclav. (R interviewee)*

> *… fever is managed once patient has been assessed and antipyretics are usually accompanied by IV antibiotics as per policy. (Participant 106, questionnaire)*

It appeared as if the relationship between fever and the Sepsis Six bundle became routinised, making antibiotics one of the interventions to manage fever. However, only antipyretics can directly moderate pyrexia. Antibiotics should be prescribed to treat infection, as one of the causes of fever. The question arises as to whether the Sepsis Six is too quickly and intuitively utilised when sepsis is not the underlying cause of fever, and antibiotics administered. Logically there is no evidence to support the use of the Sepsis Six bundle with non-septic patients, and it is clearly undesirable to use antibiotics in non-infected fever patients. The evidence generated from the interviews showed that antibiotics were commonly prescribed for fever patients although it was doubtful that their administration was always necessary.

5.8.1 Antimicrobial resistance

For many decades, humans and animals have relied on antibiotics and other antimicrobials to control infections. However, as a result, the microbes causing infections are developing resistance to the drugs. As previously stated (Section 2.3.2), if this continues it is estimated that by 2050 the world will face an additional 10 million deaths due to antibiotic-resistant infections at a cost of 100 trillion US dollars to the global economy. Nevertheless, only two new antibiotic classes have been introduced in the last 40 years, indicating that there are no new drugs in our armoury to fight antibiotic-resistant bacteria (Alanis, 2005; Spellberg et al., 2013; Fair and Tor, 2014; Ismail et al., 2015; Roca et al., 2015; Wright, 2016). Thus, feasible ways to tackle AMR are a high priority for the WHO, as AMR is a worldwide problem (Ventola, 2015; WHO, 2015). Reducing the unnecessary and inappropriate use of antimicrobials has become a public health priority in an attempt to control increasing AMR (Bush et al., 2011; Laxminarayan et al., 2013; Spellberg et al., 2013; Fair and Tor, 2014; Berendonk et al., 2015; Wright, 2016; European Centre for Disease Prevention and Control, 2018). The European Commission has listed the prudent use of antimicrobials as its primary goal (Commission, 2017). However, according to Health Protection Scotland (2018), the 2017 annual report showed that the use of antibiotics in Scotland’s acute hospitals was 18% higher than in 2013. Although the incidence of bacteraemia and non-susceptibility remained stable in Scotland from 2013 to 2017, it was found that resistance to some antibiotics was consistently high. For example, the incidence of cefuroxime-resistant Escherichia coli increased by 2% from 2013 to 2017.

Furthermore, the emergence of vancomycin-resistant Enterococcus faecium bacteraemia continued to increase from 2013 to 2017 at a rate of almost 20%. Meanwhile, the proportion of gonorrhoea infections with azithromycin resistance observed a 1.6% increase. The above incidences added to the overall burden of AMR on the health services (Health Protection Scotland, 2018).

It is of concern that instituting the Sepsis Six for fever patients ‘just in case’ who prove to be neither septic nor infectious, could potentially increase the risk of AMR. Therefore, it is of concern when clinicians manage fever patients with antibiotics when the underlying cause of their fever is not infection, especially when the decision-making process of this fever management is intuitive.

5.8.2 Adopting the guidelines

Aside from increasing the risk of AMR, the emphasis of the Sepsis Six also encouraged nurses to provide fever management. However, there was no published data about the benefits of the interventions which could be unnecessary for patients with pyrexia. Nurses’ preference for employing the Sepsis Six bundle was enhanced by an emphasis on the consequences of septic shock. Participant 16 articulated her clinical observation.

> *I still think there is poor understanding that a 'Fever' is not necessarily a bad sign and that it is a natural process. The sepsis protocol is essential and really good but can reinforce 'fever fear'. (Participant 16, questionnaire)*

Similarly, Interviewee M pointed out the raised awareness of the Sepsis Six bundle as in the previous quote.

> *When I qualified as a nurse, probably, that was about the time when sepsis was gaining a high profile. I remember when I was a student nurse, being aware of the changes in language*

> *around fever and the importance of sepsis. Sepsis just becoming a much more, not just within nursing, but also within the wider public, as a thing. I think people were always aware of septic shock, that term, but never really knew what sepsis was or how prevalent it was. I remember just before I qualified, and then just after qualifying, that whole Sepsis 6 bundle rolled out. There was a lot of focus on meeting all the six criteria in the bundle … it was good, particularly if you had not seen a septic patient or a suspected sepsis for a while. You were able to follow that, my patient has this, this, this. Needs this. And it would tell you the next thing to do. (M interviewee)*

In this conversation Interviewee M referred to the emphasis on the Sepsis Six bundle and also suggested that the application of the care bundle was wider, this resonates with the findings discussed in Sections 4.3.4.1 and 4.4.3. It seemed that employing the Sepsis Six protocol was one of the most popular managements for nurses when managing fever patients. The question remained as to whether it was necessary to assiduously adopt the Sepsis Six bundle with every fever patient.

Greenhalgh (2018) illustrated the dangers of replacing apparent data with evidence-based guidelines in her personal experience. She had been admitted to hospital because of an injury from a bike accident. The incident resulted in fractured arms with numbness in both of the hands. While in the hospital, she was x-rayed and assessed through the falls prevention checklist by the clinicians, but no one ordered imaging studies of his cervical spine. Eight months later, a cervical spine injury was diagnosed, and surgery was performed. It was argued that unconscious use of the guidelines might have been because people unconsciously simplified the issues to make the problem possible to cope with cognitively and manage practically. Even though making the right moral choice or decision for the patient at the right time might not depend on guidelines (Tonelli, 1998; Kelly et al., 2015; Engebretsen et al., 2016). In this case, guidance for both cervical spine injury and risk of fall was available. The experience of Greenhalgh (2018) gave a critical debate on the prudent use of guidelines. Accordingly, Greenhalgh (2018) raised the questions about why a cervical spine injury was not suspected when instead the risk of the fall was assessed.

During the last 50 years, there has been a strong movement towards standardisation of medical practice through protocols and clinical guidelines. However, it has been criticised that these protocols or guidelines focus on the care of the population, while clinical practice is about the care of individuals (Tonelli, 1998; Kelly et al., 2015; Engebretsen et al., 2016). The clinical guidelines have subtly shifted away from individual assessments and diagnoses (Tonelli, 1998; Mercuri et al., 2015; Stendal, 2015; Greenhalgh, 2018). Accordingly, it has been observed in many clinical cases that clinicians tend to assign a patient to a particular set of guidelines rather than make a clinical judgement with consideration of the patient’s individuality (Engebretsen et al., 2016; Greenhalgh, 2018). Real-world decision making often involves numerous options, outcomes and contextual factors. However, with the enhancement of protocols and guidelines, clinicians are inclined to rely on a narrow, rule-based approach to clinical practice. The complex nature of clinical judgement is not fully accommodated in this approach. As a result, humans unconsciously simplify the problem to make it possible to cope cognitively and manage practically (Tonelli, 1998; Mercuri et al., 2015; Stendal, 2015; Greenhalgh, 2018).

The use of protocols and guidelines is not necessarily a bad thing. However, it is important that clinicians master the guidelines rather than become mastered by them. For instance, in this study participants relied on certain guidelines, such as the Sepsis Six bundle, when pyrexia was observed. Nevertheless, different values should underpin different priorities resulting in different judgements. Protocols or guidelines should be applied when needed instead of being the first line of approach in nursing care. The care should be based on individual need and nurses should seek patient-based evidence in order to provide person-centred care (McCormack and McCance, 2006).

5.9 Over treating fever

From this study's results, it showed significant relationships between fever knowledge and management were scarce (see Appendix K). The significant relationship in fever knowledge and fever management demonstrated a weak association. It appeared that most of the participants chose to manage fever even when it might not have been necessary. Following a discussion of factors that might have impacted on the decision-making process, this section focuses on the results of the fever management. According to the dual process theory of decision making (Figure 5.4), there could be four possible outcomes from a decision: right management and the patient becomes better; wrong management yet the patient becomes better; right management yet the patient becomes worse; and wrong management and the patient becomes worse.

Although many articles concerning sepsis have emphasised the importance of insufficient fever management, an example of wrong fever management, only a few have mentioned the side effects of over treating fever. To investigate this further, I reviewed published evidence about the benefits of fever. Hasday and Singh (2000) published a literature review and found that in several animal studies, fever could decrease bacterial load because for most of bacteria reproduction was inhibited at a higher temperature. Eventually, this could increase the host's survival (Bell and Moore, 1974; Jiang et al., 2000; Blatteis, 2003; Harden et al., 2015). Moreover, it was observed that heat stress, such as pyrexia, has some beneficial roles in organisms, as it helps regulate proliferation and differentiation in mammalian cells. In addition, heat stress can activate the immune response (Park et al., 2005; Horváth et al., 2008; Hasday et al., 2011; Velichko et al., 2013), and also at a raised temperature the human body has a higher metabolic rate. With this higher metabolic rate, innate defences, such as the white blood cells, are delivered to the organs more effectively (Park et al., 2005; Horváth et al., 2008; Velichko et al., 2013; Fiala and Havenith, 2015; Morrison, 2016; Zaretsky et al., 2018). Therefore, it can be concluded that fever can destroy pathogens or inhibit their growth by activating, modifying and orchestrating host defences (Hasday et al., 2000; Hasday and Singh, 2000; Jiang et al., 2000; Park et al., 2005; Hasday et al., 2011; Fiala and Havenith, 2015; Harden et al., 2015). Consequently, the administration of antipyretic agents could increase bacterial growth and delay or interrupt the defensive immune response (Hasday et al., 2000; Scrase and Tranter, 2011). This, eventually, could lead to a delay in the recovery of fever patients. However, the outcome of the delayed recovery would not be acute and might be difficult to observe.

It was determined that although the standardised guidelines provide an evidence-based environment, they were developed to meet the needs of populations while patient care should be person-centred, and the guidelines should be used only when a situation matches instead of in similar scenarios. Clinicians should master the guidelines rather than become mastered by them.

Beside intuition and prudent use of guidelines, the ‘Bandwagon’ effect was suspected to have an influence on fever management. As in the clinical environment, there are always time-management issues or pressure from patients. Therefore, following the management approach of the majority seems to be the safe option. To minimise the effect, clinical decisions on the best available evidence and independent, critical thinking should be enhanced when managing fever (Rikkers, 2002: 791).

The many disadvantages of over treating fever was one of the themes discussed in this study. However, compared to undertreating fever, most clinicians choose to over treat. It was found that the fear of not treating fever weighs more than that of over treating fever, as the side effects of over treating fever are usually chronic and indirect. As a result, most of the participants would treat fever immediately, their decision being driven by their fear of fever.

CHAPTER SIX: CONCLUSION

6.1 Introduction

The conclusion to this thesis is presented in this final chapter. To begin, a summary of the research project is provided and the strengths and limitations of the research discussed. The implications of this research are set out and, lastly, suggestions for future research, are put forward.

6.2 Summary of this thesis

Following the critical review of the literature conducted with reference to my research focus and concern, this study was designed to understand how nurses use knowledge of fever in their clinical decisions on pyrexia-related nursing interventions to manage fever in the adult patient.

Specifically, the findings of this study have addressed the following research objectives:

- To understand nurses' decision-making process in the management of fever
- To explore how knowledge acquisition influences nurses' decisions in the management of fever
- To identify factors that influence the knowledge acquisition in the management of fever.

To conduct this research, a mixed-method strategy was applied to analyse nurses' knowledge about fever and their management of fever in the clinical context. A pre-validated questionnaire, adapted from Walsh et al. (2005), Thompson et al. (2007) and Kiekkas et al. (2014), was used to measure the study participants' knowledge about fever and to understand their management of fever. This online questionnaire was distributed by means of the RCN, every NHS Board in Scotland and snowball sampling. Following the completion of the questionnaire, participants were asked to provide their contact information if they were willing to participate in an interview. Those who voluntarily left their contact information were subsequently contacted and invited to be interviewed. For the quantitative approach, survey data was collected from a total of 177 registered nurses in Scotland from January 2017 to August 2017, while for the qualitative approach five interviews were conducted after a brief analysis of the survey from July 2017 to September 2017.

Based on the results of the questionnaire, considerable misconceptions were found to exist in the nurses’ understanding of fever and its management. The findings were categorised into two parts: fever knowledge and fever management. The scope of each part was narrowed down in Chapter 4, where both the quantitative and the qualitative findings about fever knowledge and fever management are presented with the relationship between the two shown; and also in Chapter 5, where the theoretical frameworks are presented for understanding fever knowledge and fever management.

Analysis of the questionnaire results revealed issues related to nurses’ fever knowledge. Through analysis of associations and in-depth interviews, it was found that many factors had contributed to the nurses’ knowledge about fever, specifically educational content, individual confidence, the Sepsis Six bundle and a lack of access to up-to-date scientific evidence. As to fever management, the survey revealed that paracetamol was frequently given to patients with fever to reduce their temperature and ease discomfort. This finding indicated that participants were keen to administer antipyretics because they believed controlling fever would have the benefit of decreasing the length of the patient’s hospital stay as well as reducing mortality. This finding was consistent with the result that participants were consistently anxious, even phobic about the presence of fever in any clinical situation. It was found that the nurses’ initial interpretations of fever, the Sepsis Six bundle, and fever phobia were the three main factors that influenced how participants managed fever. As a result, due to the strong influence of the Sepsis Six bundle, participants often assumed a direct causal connection between fever and infectious disease or sepsis. Accordingly, one of the most common approaches in fever management was to administer antibiotics. Indeed, it was found that fear of fever was a key element that prompted nurses to initiate fever management. Consequently, in the majority of cases fever was often managed by participants in response to this fear.

Inconsistencies between the participants’ knowledge of fever and their management of fever were also noted. However, it was found that nurses rarely took steps to reduce the gap between the two. The results of this study, and results reported in the literature, were further investigated and were found to be in accord with existing accounts of the generation of knowledge into management theory and the dual process theory of clinical decision making. The two models were developed and presented in Chapter 5. Through the analysis of dual process decision making theory, it was demonstrated that nurses are prone to rely on their intuition and embedded assumptions when considering the management of a patient presenting with a fever. Moreover, they seldom appeared to critically reflect on their management decisions. This studies results suggest that nurses are discouraged to have second thoughts about their decisions. As a result, a more intuitive approach is applied when encountering fever patients. The use of intuition, the making of rapid, arguably assured decisions only encourages further intuitive decision making and discounts the need for rational evidence-based decision making. This, despite the exhortation for the profession to be evidence based.

6.3 Strengths and limitations of this research

By applying a mixed method research strategy, the study produced and analysed rich research data using multi-dimensional analyses. Moreover, this method assured the reliability and validity of the quantitative results. Following an initial analysis of the survey data, qualitative research was conducted in a semi-structured way, helping to support and enrich the quantitative data.

Although fever is a very common symptom in the clinical environment (Ogoina, 2011; Baran and Turan, 2018), there is little published data regarding nurses’ knowledge of adult patients’ fever (Chiu, 2012; Kiekkas et al., 2014). The findings of this study included an evaluation of nurses’ knowledge about fever and their understanding of the different causes of fever, as well as their current clinical performance in managing fever. To date, the management of fever has been discussed mostly in the areas of neurology and critical care clinical settings (Pickard and Czosnyka., 1993; Jones et al., 1994; Castillo et al., 1998; Rumana et al., 1998; Schwarz et al., 2000; Stocchetti et al., 2002; Childs et al., 2008; Carey, 2010). Although some literature addressing fever managements was located, it essentially compared different antipyretic methods (Çelik et al., 2011; Niven et al., 2013; Kiekkas et al., 2013; Long and April, 2017). The literature review found only one article that examined the application of all types of fever management in clinical settings (Chiu, 2012). Besides providing evidence about nurses’ fever knowledge and fever management, the present study also explored cognitive aspects of knowledge construction in building nurses’ fever knowledge, and their utilisation of fever knowledge while managing fever in clinical practice. This is an approach which the established research on nursing has rarely taken.

All research has limitations that are determined by its context, and this research was no exception. There were two main areas of limitation; these were in the recruitment and data collection phase and during the analysis as discussed in Section 3.7.

The data collection method for the survey provided flexible strategies to approach potential participants. The routes of access were mainly via the RCN, the NHS health care boards in Scotland, and by snowball sampling. However, the approaches taken varied because different institutions distributed the questionnaire in different ways. For instance, the RCN sent the information through email. Nevertheless, the email was sent to selected members of the RCN and the selection process was not very clear. As in each NHS health care boards in Scotland, the information was first sent to the Lead Practitioner Research or Director of Nursing, Midwifery and Allied Health Professions, or those who occupied equivalent positions. The Lead Practitioner Research or Director of Nursing, Midwifery and Allied Health Professions then helped to relay the information. Yet, each board had its own way of distributing the questionnaire. Most of the Lead Practitioners of Research or Directors of Nursing, Midwifery and Allied Health Professions sent the information of this research to the head nurses and the head nurses then relayed the information to staff nurses by email. Other health care boards provided information about the survey during a meeting, for example, a morning meeting. Together with the convenience sampling, the diverse methods of questionnaire distribution made calculating the response rate difficult, as it was uncertain who had received the information about the study. Moreover, there is doubt about whether the instrument of this study accurately reflected the latest scientific evidence. For example, the heart rate increases associated with a rise in every 1℃ in core temperature, ranged from 7-12 beats per minute (Porth 2011, Jensen and Brabrand, 2015; Kirschen et al., 2019). Also, in question 25, the beneficial consequences of fever can include both increased antibody production and increased heart rate. Those could be a concern whether the instrument can truly reflect the participants' knowledge.

Another limitation was that the interview was limited to participants who had already completed the survey. This excluded some participants who had not yet completed the survey and made it difficult to recruit a larger number of participants for the interviews. However, the interview data demonstrated that it had reached a point of saturation as the participants were repeating the same themes. Also, the researcher's mother tongue was not English. Therefore, it was sometimes difficult for the researcher to understand the heavy Scottish accent of some of the interviewees. It was, however, possible to clear up any misunderstandings during the interviews. Additionally, some information from the interview setting could not be recorded, such as a facial expression which could change the meaning of a sentence, and it was difficult to remember everything that was seen in each interview as the interviews were only audio recorded. To reduce errors in transcribing the interviews, a summary of the content and field notes, or the conclusion of each interview, were sent to each respective participant by email for checking and confirmation of its accuracy (Creswell and Miller, 2000; Cho and Trent, 2006; Houghton et al., 2013). It is noteworthy that this process for checking accuracy also served to improve the validity of the qualitative data.

Mixed method research generally takes more time to conduct than does a single method approach. The analysis of mixed method research can become complicated because the quantitative and qualitative perspectives are very different (Johnson and Onwuegbuzie, 2004; Teddlie and Tashakkori, 2010; Tariq and Woodman, 2013; Yardley and Bishop, 2015; Kaur, 2016; Brannen, 2017; Bressan et al., 2017; Onwuegbuzie et al., 2017). Although use of the mixed method research design added greater value to the results of this research, such analyses are challenging within a limited timeframe. In order to get a better picture of the issues present in fever knowledge and fever management a brief analysis of the survey results was conducted before each interview so that the research could use appropriate questions in the interviews.

Both the data collection and the survey analysis took time. Therefore, by the time the interviews were conducted, some of the interviewees had forgotten some of details of the questionnaire. Moreover, it was challenging for the researcher working alone to condense the lengthy data collection and to offer an analysis of the survey.

To broaden the validity and impact of this research, it would be useful to reflect on the research findings and theoretical models against those found in

1) other geographical areas across the UK or in other countries, and

2) other participant groups, such as nursing students, to investigate transferability of the findings and models.

6.4 Implications of this research

The following section discusses the potential implications of this study’s findings for hospitals, nurses and researchers.

The findings of this research help to define the issues that underlie nurses’ fever knowledge and fever management in Scotland, and contribute to the construction of theoretical models for knowledge generation in fever and dual process decision making among nurses treating patients with fever. By introducing and discussing factors and elements that influence nurses’ fever knowledge and fever management, as well as theoretical models, this research concludes that there are numerous ways to improve fever management by nurses in the clinical setting. Therefore, it would be useful for hospitals and nurses to understand the current issues in fever management.

This research found that nurses’ knowledge of fever and how it should be managed remained of concern, and as a result, their fever management did not always follow the latest scientific evidence. Of note was the fact that, when probed, the interviewed participants, initially confident about their fever knowledge and management began, on personal reflection, to express concerns as presented in section 4.4.6.

In this section, I move on to discuss the original contributions of this study. These are the relationships and factors influencing fever knowledge and fever management, from four perspectives in the light of their implications for nursing education, practice and future research.

6.4.1 Nursing education and practice

1) Firstly, for effective clinical education, nurses should be supported by a learning environment that enables discussion of real problems identified in the clinical setting. This would allow nurses to discuss the management about which they were uncertain, instead of performing less ideal interventions devoid of critical and rational reflection.

2) Some of the participants expressed the need to have more up-to-date information about fever as they lack access to new knowledge once they have left their educational institute, suggesting that this should be an in-service and employment provision.

3) It is clear that enhanced evidence of current clinical practice in fever management, and factors that influence nurses' management of fever, is required, as most of the participants were not aware that their fever management was out of date, inadequate or inappropriate. By so doing, it is argued that the frequency of overtreatment of fever in the clinical environment could be reduced. With better understanding of the factors that influence fever management, nurses might be more relaxed about letting modest fever take its course and not stepping in immediately with treatment or management. The eventual goal is to encourage nurses to assess a febrile patient and make a clinical judgement based on all the symptoms, and the clinical context, and not just the patient's temperature.

4) This study found that healthcare guidance, such as the Sepsis Six, had a strong influence on nurses' decisions to treat fever. Leading to management without wider consideration of an individual's condition, but only depending on the guidance which could be inappropriate. As a result, a more person-centred care approach to fever management should be promoted.

6.4.2 Future research

1) A future study could test the theoretical frameworks developed in this study.

2) This study should be conducted in other geographical areas across the world and involve other types of disorders in order to investigate whether the findings reflect culture and clinical practice in Scotland alone, or if they are representative of worldwide concerns.

3) The findings of this study indicate that there is a need to design interventions to improve fever management in the clinical context, for example assessing fever symptoms. Future studies focussing on the relationship between fever management and antibiotics might lead to a reduction in the incidence of antimicrobial resistance, as this study found that antibiotics were often given to febrile patients to reduce fever symptoms rather than treat infections.

4) There is a trend towards the development of healthcare guidelines (Alvarez et al., 2018; Holman et al., 2018; Dilley et al., 2019). However, this study demonstrated that applying such guidelines without consideration of each individual case can be inappropriate. A longitudinal research study, focussing on the implications of the use of protocols and guidelines in healthcare settings could highlight the benefits and disadvantages of this approach.

6.5 Closing considerations

According to the NHS Improvement Hub patients should be treated in a safe environment and protected from avoidable harm (NHS Improvement, 2020). Nurses’ fever management should therefore be provided to patients under safe conditions. To achieve this, nurses should be equipped with the necessary knowledge and practical skills to ensure the competency required by their profession, even in an environment of rapid advancements and continuous implementation in healthcare. Providing high quality nursing care to patients is the priority goal.

The original aim of this research was to have a better understanding of nurses’ knowledge of fever and how nurses employ pyrexia-related nursing interventions to manage adult patients’ fever. This study presents an overview of nurses’ knowledge and management of fever. At the same time, inconsistencies were revealed between nurses’ knowledge of fever and their management of fever. As a result, the scope of topics that were examined gradually narrowed. Based on the results of this study and the literature review, the construction of two theoretical models was undertaken.

The analysis of the process of knowledge formation specific to fever demonstrated that both the Sepsis Six, and nurses’ past experience, played an important role in the formation of the nurses’ knowledge. It was found that experience helped in the internalisation process of fever knowledge, with knowledge generation facilitating a broad perspective and a better understanding of the cognitive knowledge-building process. Eventually, the formation of such fever knowledge determines the decision about fever management in the clinical setting. The theoretical model of dual process decision making offered a deeper understanding of nurses’ judgements when managing patients with fever. It was discovered that nurses acted to reduce fever because of their fear of fever. According to the dual process theory of decision making in the context of fever, fear of fever was not only enhanced by the implementation of the Sepsis Six, but it also reinforced this fear when the condition of a patient with fever worsened. This vicious cycle made the administration of antipyretics to fever patients an intuitive reaction by nurses; one which they took for granted.

The adoption and application of both theoretical frameworks can not only improve nursing healthcare and decision making, but it can also assist in increasing clinical education about fever. Moreover, the key message is to critically rethink the routine management of patients with a fever, instead of 'taking the management for granted'. Ultimately, the value of the findings of this research is to help fulfil the basic aim of ensuring the highest quality of nursing care and decision making for patients.

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APPENDICES

Appendix A: Letter of Approval

Ref: NURS019

Anny Chen
Nursing Studies
School of Health in Social Science
Medical School
Teviot Place
Edinburgh
EH8 9AG

SCHOOL OF HEALTH IN SOCIAL SCIENCE
The University of Edinburgh
Doorway 6
Medical Quad
Teviot Place
Edinburgh
EH8 9AG

E-mail: [redacted]
E-mail: [redacted]

25/01/2017

Dear Anny

APPLICATION FOR LEVEL 1/2/3 APPROVAL

PROJECT TITLE: A STUDY TO UNDERSTAND NURSES’ KNOWLEDGE AND MANAGEMENT OF FEVER IN HOSPITALISED ADULTS

Thank you for submitting the above research project for review by the Section of Nursing Studies Ethics Research Panel.

I can confirm that the submission has been independently reviewed and was approved on **25/01/2017**.

Should there be any change to the research protocol, it is important that you alert us to this as this may necessitate further review.

Yours sincerely

S Kean   Sarah J. Rhynas

Susanne Kean
Researcher/Lecturer
Nursing Studies

Sarah J Rhynas
Teaching Fellow
Nursing Studies

Appendix B: Fever Survey

Fever Survey (Lothian)

Page 1

Please read the following information carefully. This is a study involving a questionnaire to understand nurses' knowledge about fever and the management of fever. I am conducting this study as part of my PhD in nursing.

Fever is a very common symptom in the clinical environment reflecting a raised body temperature. This questionnaire takes approximately about 20-30 minutes to complete. On completion of the questionnaire, you will be directed to further literature about fever which will enhance your continuing professional development in this area.

The information collected in the questionnaire is anonymised and will be kept confidential. The information you share with me is for the purpose of this study and will only be accessed by myself and my supervisors. The information collected from you will be stored securely and password-protected within the university. By agreeing to return the questionnaire, you are consenting to my use of the data and the assurances given above.

Anny Chen

PhD student in Nursing Studies

School of Health in Social Science

University of Edinburgh

e-mail: s1465811@sms.ed.ac.uk

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Demographic Data

1. Gender ✱ *Required*

2. Age ✱ *Required*

Your answer should be no more than 2 characters long.

3. Where are you working? ✱ *Required*

If you selected Other, please specify:

4. Type of institution in which you primarily practice: ✱ *Required*

- Medical centre
- Hospital
- Rehabilitation facility

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- Nursing home
- Community health
- Clinic
- Higher education institution (HEI)
- School
- Other

If you selected Other, please specify:

5. Approximate number of beds in your unit: *Optional*

Your answer should be no more than 3 characters long.

6. Type of unit(s) in which you currently work (if in a hospital setting): (Please tick all appropriate responses) ✱ *Required*

- Critical Care
- Acute Care
- Surgical Unit
- Medical Unit
- Neuroscience Unit
- Paediatric Unit
- Rehabilitation Unit
- Psychiatric Unit
- Other
- Not in a hospital setting

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If you selected Other, please specify:

7. Type of unit(s) in which you have previously worked: (Please tick all appropriate responses) * Required

- Critical Care
- Acute Care
- Surgical Unit
- Medical Unit
- Neuroscience unit
- Paediatric Unit
- Rehabilitation Unit
- Psychiatric Unit
- Theatre
- None
- Other
- Not in a hospital setting

If you selected Other, please specify:

8. What is your primary role? * Required

- Registered Nurse

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- ☐ Charge Nurse
- ☐ Manager
- ☐ Research Nurse
- ☐ Nurse Practitioner
- ☐ Nurse Specialist
- ☐ Lecturer
- ☐ Other

If you selected Other, please specify:

9. What is your level of nursing education? (Please tick all appropriate responses) * *Required*

- ☐ State Registration Programme
- ☐ Registered General Nurse Diploma
- ☐ Nursing Degree-BSc/BN
- ☐ Nursing Degree-BSc Hon/BN Hon
- ☐ Post Graduate/ Qualification-Diploma
- ☐ Post Graduate/ Qualification-Masters
- ☐ Post Graduate/ Qualification- PhD/Professional Doctorate

10. How many years of experience do you have as a registered nurse? * *Required*

Your answer should be no more than 2 characters long.

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Fever Knowledge

11. Raised temperature (pyrexia) is primarily attributed to: * Required

- Pathogens
- Weakening of the body due to illness
- Immune system
- Not sure

12. Fever is raising of the body temperature due to: * Required

- Temperature auto-regulation of the body
- Increase production of core temperature without temperature auto-regulation
- Reduced loss of core temperature
- Not sure

13. The increased temperature during fever is attributed to: * Required

- Infection
- Infectious or non-infectious aetiology
- Usually non-infectious aetiology
- Not sure

14. For every 1°C rise in core temperature, heart rate increases by: * Required

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- 2 beats/ minute
- 5 beats/ minute
- 10 beats/ minute
- Not sure

15. For every 1°C rise in temperature, there is an associated increase in respiratory rate of: * Required

- 1-4 breaths per minute
- 4-8 breaths per minute
- Insignificant increase in breaths per minute
- Insignificant decrease in breaths per minute
- Not sure

16. The most accurate measurement of temperature is: * Required

- Axillary
- Tympanic membrane (Ear)
- Rectal
- Oral
- Not sure

17. Fever control by active external cooling is justified in patients with: * Required

- Head injury
- Acute kidney injury
- Malignancy

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○ Not sure

18. What degree of temperature is **NOT** accepted as fever? (Please tick all appropriate responses) * *Required*

- ☐ Rectal temperature 37.8°C
- ☐ Oral temperature 37.6°C
- ☐ Axillary temperature 37.4°C
- ☐ Tympanic membrane temperature 37.6°C
- ☐ Not sure

19. At what temperature would fever/hyperthermia cause brain damange? (Please tick all appropriate responses) * *Required*

- ☐ 39.5°C
- ☐ 40.0°C
- ☐ 40.5°C
- ☐ 41.0°C
- ☐ 41.5°C
- ☐ 42.0°C
- ☐ Not sure

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20. Antipyretics reduce fever because they: * Required

- Increase diaphoresis
- Suppress the action of prostaglandins
- Cause vasodilation
- Not sure

21. Side effects of paracetamol include: (Please tick all appropriate responses) * Required

- Nausea/ vomiting
- Convulsions
- Hepatic toxicity
- Not sure

22. A side effect of the use of active cooling (e.g use of a cooling blanket) is: * Required

- Hypothermia
- Rigour (Chill)
- Sudden increase of reduction of temperature
- Not sure

23. The maximum dose of paracetamol in 24 hours should **NOT** exceed: * Required

- 4 grams

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- 6 grams
- 8 grams
- Not sure

24. Paracetamol may cause: (Please tick all appropriate responses) * *Required*

- ☐ Liver toxicity
- ☐ Renal toxicity
- ☐ Gastrointestinal irritability
- ☐ Not sure

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25. Beneficial consequences of fever include: * *Required*

- Increased heart rate
- Decreased body metabolic needs
- Increased antibody production
- Fat catabolism
- Not sure

26. Which is **NOT** a beneficial effect of fever * *Required*

- An increase in serum iron production
- Stimulation of T-lymphocyte production
- Acceleration of white blood cell production
- Promotion of antibiotic activity
- Not sure

27. The primary danger of fever (excluding the underlying cause) is: * *Required*

- None
- Brain damage
- Febrile convulsions
- Dehydration
- Learning disability
- Not sure

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28. Controlling body temperature during fever can: * *Required*

- Reduce hospital stay
- Increase hospital stay
- Not sure

29. Controlling body temperature during fever can: * *Required*

- Reduce mortality
- Increase mortality
- Not sure

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Fever Management

30. What are the available routes of temperature monitoring on your unit? (Please tick all appropriate responses). * *Required*

- ☐ Oral
- ☐ Tympanic membrane (Ear)
- ☐ Temporal artery
- ☐ Rectal
- ☐ Pulmonary artery thermometer catheter
- ☐ Urinary bladder thermometer catheter
- ☐ Brain thermometer
- ☐ Axillary
- ☐ None of the above
- ☐ Other

If you selected Other, please specify:

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31. Select the interventions **YOU would choose** to use. Please rank up to 6 interventions of choice. If you select 2 interventions as your primary choice, select both in that column (e.g. 1st choice: select paracetamol and fan).

Please don't select more than 6 answer(s) per row.

Please select between 1 and 12 answers.

Please don't select more than 12 answer(s) in any single column.

	1st choice	2nd choice	3rd choice	4th choice	5th choice	6th choice
Paracetamol PO/Rectal	☐	☐	☐	☐	☐	☐
Paracetamol IV	☐	☐	☐	☐	☐	☐
Ibuprofen	☐	☐	☐	☐	☐	☐
Aspirin	☐	☐	☐	☐	☐	☐
Ice packs	☐	☐	☐	☐	☐	☐
Water cooling blanket	☐	☐	☐	☐	☐	☐
Air cooling blanket	☐	☐	☐	☐	☐	☐
Water pads	☐	☐	☐	☐	☐	☐
Fan in the room	☐	☐	☐	☐	☐	☐
Cool air/ air conditioner	☐	☐	☐	☐	☐	☐
Tepid sponging	☐	☐	☐	☐	☐	☐
Intravenous cold fluid	☐	☐	☐	☐	☐	☐

32. What is the frequency of the primary medication you use to treat fever/hyperthermia? (Please indicate the primary medication and frequency) ✱ *Required*

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Your answer should be no more than 100 characters long.

33. What is the dose of the primary medication you use to treat fever/hyperthermia? (Please indicate the medication and the unit of measurement) * *Required*

Your answer should be no more than 100 characters long.

34. At what temperature do **you personally** begin to treat fever/hyperthermia? (Please indicate the monitoring method and unit of measurement, e.g. Rectal 40°C) * *Required*

Your answer should be no more than 40 characters long.

°C

35. What is your primary rationale for initiating treatment at this temperature? * *Required*

- Medical direction
- National guideline
- Independent nursing judgement
- Unit protocol
- Other

If you selected Other, please specify:

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36. Does your **hospital/institution** have an explicitly written fever/hyperthermia management protocol for patients with fever? * *Required*

- No
- Yes
- Not sure

37. Does your **unit** have an explicitly written fever/hyperthermia management protocol for patients with fever? * *Required*

- No
- Yes
- Not sure

If you answered **No** or **Not sure** to both of the questions in this page, please skip the next page. Thank you!

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38. Select the interventions included in your **institution/unit(s) protocol**. Please rank up to top 6 interventions of choice. If you select 2 interventions as your primary choice, select both in that column (e.g. 1st choice: select paracetamol and fan). *Optional*

Please don't select more than 1 answer(s) per row.

Please select between 1 and 12 answers.

Please don't select more than 12 answer(s) in any single column.

	1st choice	2nd choice	3rd choice	4th choice	5th choice	6th choice
Paracetamol PO/Rectal	☐	☐	☐	☐	☐	☐
Paracetamol IV	☐	☐	☐	☐	☐	☐
Ibuprofen	☐	☐	☐	☐	☐	☐
Aspirin	☐	☐	☐	☐	☐	☐
Ice packs	☐	☐	☐	☐	☐	☐
Water cooling blanket	☐	☐	☐	☐	☐	☐
Air cooling blanket	☐	☐	☐	☐	☐	☐
Water pads	☐	☐	☐	☐	☐	☐
Fan in the room	☐	☐	☐	☐	☐	☐
Cool air/ air conditioner	☐	☐	☐	☐	☐	☐
Tepid sponging	☐	☐	☐	☐	☐	☐
Intravenous cold fluid	☐	☐	☐	☐	☐	☐

39. What is the frequency of the primary medication you use, **according to the Institution/unit(s) protocol,** to treat fever/hyperthermia? (Please indicate the primary

medication and frequency) *Optional*

Your answer should be no more than 100 characters long.

40. What is the dose of the primary medication you use, **according to the institution/units(s) protocol**, to treat fever/hyperthermia? (Please indicate the medication and unit of measurement) *Optional*

Your answer should be no more than 100 characters long.

mg

41. **Base on this unit/intitution protocol**, at what temperature do you begin to treat fever/hyperthermia? (Please indicate the monitoring method and unit of measurement, e.g. Rectal 40°C) *Optional*

Your answer should be no more than 40 characters long.

°C

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Is there anything else regarding fever management that you would like to share with us?

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If you have any questions about this study, please contact Anny Chen (s1465811@sms.ed.ac.uk), Prof. Tonks Fawcett (T.Fawcett@ed.ac.uk) or Dr. Colin Chandler (Colin.Chandler@ed.ac.uk). If you are interested in being involved in a second part of this research, please leave your contact information (the contact information will only be used for the purpose of further study).

I consent the information that I have provided in the questionnaire to be used for academic purposes. * *Required*

- Yes
- No

The following are some articles about fever that you might find helpful. If you need to keep access to those references, please copy and paste them into a document or contact Anny Chen (s1465811@sms.ed.ac.uk) :

Please use the link through a device that has access to the RCN publication, for example, your hospital or your educational institution

- http://journals.rcni.com/doi/pdfplus/10.7748/ns.31.3.18.s22
- http://journals.rcni.com/doi/pdfplus/10.7748/ns.29.29.37.e7257
- http://journals.rcni.com/doi/pdfplus/10.7748/ns.2016.e10289
- http://journals.rcni.com/doi/pdfplus/10.7748/ns.30.35.51.s48

If you have any concerns about the study please contact the Head of School, School of Health in Social Science, University of Edinburgh. (hos.health@ed.ac.uk)

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Key for selection options

1 - 1. Gender

- Male
- Female

3 - 3. Where are you working?

- Ayrshire & Arran
- Borders
- Dumfries & Galloway
- Fife
- Forth Valley
- Grampian
- Greater Glasgow & Clyde
- Highland
- Lankshire
- Lothian
- Orkney
- Shetland
- Tayside
- Eileanan Siar Western Isles
- Other

Appendix C: Informed Consent and Information Sheet of Interview

Interview Consent form

Research project title: A study to understand nurses' knowledge and management of fever in hospitalized adults.
Research investigator: Anny Chen
Participant:

By signing this form, I agree that: **Please initial box**

1. I am voluntarily taking part in this project. I understand that I do not have to take part, and I can stop the interview at any time; ☐
2. The transcribed interview or extracts from it may be used as described in the information sheet; ☐
3. I have read the Information sheet; ☐
4. I have been able to ask any questions I might have and I understand that I am free to contact the researcher with any questions I may have in the future. ☐
5. The interview will be recorded and transcribed. ☐
6. Access to the interview transcript will be limited to Anny Chen and academic supervisors (Dr. Colin Chandler and Prof. Tonks Fawcett). ☐
7. The digital recording will be stored securely and destroyed according to the university guidelines. ☐
8. This research may be published through publications and conference presentations but any summary content or direct quotations will be anonymized. ☐
9. Any variation of the conditions above will only occur with your further explicit approval. ☐

________________________________ Printed Name

________________________________ ________________
Participant's Signature Date

________________________________ ________________
Researcher's Signature Date Contact Information

Interview Information sheet

Research project title: A study to understand nurses' knowledge and management of fever in hospitalized adults.
Research investigator: Anny Chen

The study purpose

This study is part of my PhD in Nursing. You are invited to take part in this interview about fever management and knowledge. Fever is a very common symptom in the clinical environment reflecting a raised body temperature. However, I wish to explore to what extent nurses have practised with the latest evidence. The purpose of the interview is to understand nurses' knowledge and management of fever in hospitalized adults. The interview will take approximately 45 minutes. Please read the following information carefully.

The likely benefits and risks

This study will help us to understand the current management of fever and may also help develop and improve current practice. There are no potential risks associated with your participation but you have the right to stop the interview or withdraw from the research at any time without giving a reason.

Confidentiality and publications

The information you share with me is for the purpose of this study and will only be accessed by myself and my supervisors (Dr. Colin Chandler and Prof. Tonks Fawcett). The study will be written up as a publication for a peer reviewed scientific journal. All the data will be anonymized. Anonymized quotations may be used in reporting the study. There will be no identifiable data in the published results.
The information collected from you will be stored securely and password-protected within the university and will be destroyed in accordance with university guidelines.

If you have any questions about this study, please contact Anny Chen ([redacted].ac.uk) phone [redacted], Prof. Tonks Fawcett (T.Fawcett@ed.ac.uk) or Dr. Colin Chandler [redacted]d.ac.uk).

If you wish to discuss this research with a person not related with the study, please contact Dr. Susanne Kean ([redacted]c.uk) phone [redacted]

Concerns and complaints
If you have a concern or complaint about the study, please contact the head of school, Prof. Charlotte Clarke, School of Health in Social Science, University of Edinburgh. (hos.health@ed.ac.uk)

Anny Chen
PhD student in Nursing Studies
School of Health in Social Science
University of Edinburgh
e-mail: [redacted]ac.uk

Appendix D: Knowledge questionnaire by Kiekkas et al. (2014) in English

1. Raised temperature (pyrexia) is attributed to:

-Pathogens

-Weakening of the body due to illness

-Immune system

-Not sure

2. Fever is raising of the body temperature due to:

-Temperature auto-regulation of the body

-Increase production of core temperature without temperature auto-regulation

-Reduced loss of core temperature

-Not sure

3. The increased temperature during fever is attributed to:

-Infection

-Infectious or non-infectious aetiology

-Usually non-infectious aetiology

-Not sure

4. For every 10◦C in core temperature, heart rate increases by:

-2 beats/ minute

-5 beats/ minute

-10 beats/ minute

- Not sure

5. The most accurate measurement of the temperature is made in:

-axillary

-ear

-bladder

-Not sure

6. Fever control by active external cooling is justified in patients with:

-Head injury

-Acute Kidney Injury

-Malignancy

-Not sure

7. Antipyretics reduce fever because:

-they increase diaphoresis

-Suppress the action of prostaglandins

-Cause vasodilation

-Not sure

8. Side effects of paracetamol include:

-Nausea/ vomiting

-Convulsions

-Hepatic toxicity

-Not sure

9. A side effect of the use of active cooling (i.e. use of cooling blanket) is:

-Hypothermia

-Rigor

-Sudden increase or reduction of temperature

-Not sure

10. The maximum dose of paracetamols in 24 hours should not be more than:

-4.5 grams

-6.5 grams

-8.5 grams

-Not sure

Appendix E: Knowledge questionnaire by Walsh et al. (2005)

Table 4. Knowledge section of the questionnaire.

Questions 18 Knowledge of the physiology of fever

1. The body's thermoregulating centre is located in the:
   1. Cerebrum
   2. *Hypothalamus (n = 103, 86.6%)*
   3. Medulla
   4. Pons
   5. Unsure
2. Most elevated temperatures in young children are the result of:
   1. *Viral Infection (n =103, 86.6%)*
   2. Overdressing
   3. Bacterial Infections
   4. Vascular disease
   5. Unsure
3. Beneficial consequences of fever include:
   1. Increased heart rate
   2. Decreased body metabolic needs
   3. *Increased antibody production (n = 92, 77.3%)*
   4. Fat catabolism
   5. Unsure
4. For every 1°C rise in temperature there is an associated increase in respiratory rate of:
   1. *1–4 breaths per minute (n = 47, 39.5%)*
   2. 4–8 breaths per minute
   3. Insignificant increase in breaths per minute
   4. Insignificant decrease in breaths per minute
   5. Unsure
5. Which is NOT a beneficial effect of fever?
   1. *An increase in serum iron production (n = 40, 33.6%)*
   2. Stimulation of T-lymphocyte production
   3. Acceleration of white blood cell production
   4. Promotion of antibiotic activity
   5. Unsure
6. Which is NOT a result of fever in infants and children?
   1. Increased oxygen demand
   2. Increased fluid requirements
   3. *Increased appetite (n = 101, 84.9%)*
   4. Increased metabolic rate
   5. Unsure
7. Which of the following is TRUE regarding convulsion/seizure activity associated with fever?
   1. *Convulsions commonly occur in children with a low grade fever (n = 11, 9.2%)*
   2. Convulsions occur in more the 25% of children
   3. Convulsions that occur during fevers are strongly associated with epilepsy
   4. Convulsions are rare in children under 5 years
   5. Unsure
8. Febrile children have increased:
   (Please circle the appropriate responses)
   1. *Oxygen consumption*
   2. *Cardiac output (n = 32, 26.9%)*
   3. *Caloric requirements*
   4. Unsure

Questions 9–15 General knowledge of fever management

9. The most common side effects of fever are:
   1. Chills
   2. *Mild dehydration (n = 2, 1.7%)*
   3. Discomfort or irritability
   4. All of the above
   5. Unsure
10. The principle danger of fever (excluding the underlying cause) is:
    1. None
    2. Brain damage
    3. Febrile convulsions
    4. *Dehydration (n = 13, 10.9%)*
    5. Learning disabilities
    6. Unsure
11. Sponging febrile children with tepid water may be implemented:
    1. When an antibiotic is given
    2. *30 minutes after the administration of an antipyretic (n = 46, 38.7%)*
    3. When the temperature is below 40°C
    4. When irritability and crying are present
    5. Unsure
12. Which is NOT a sign of dehydration in infants?
    1. Depressed fontanelle
    2. Scanty urination
    3. *Tearful crying (n = 114, 95.8%)*
    4. Dry mucous membranes
    5. Unsure

(continued)

Table 4. (continued)

13. All children with fever require:
  1. Antibiotics
  2. Antipyretics
  3. Hospitalization
  4. *Thorough physical assessment (n = 67, 56.3%)*
  5. Unsure

14. Decisions on how to treat a child with febrile illness should be made on the basis of:
(Please circle all appropriate responses)
  1. *Temperature readings*
  2. *Physical examinations (n = 60, 50.4%)*
  3. *Child's health history*
  4. Unsure

15. An increased temperature in children can also be the result of:
(Please circle the appropriate responses)
  1. *Overdressing*
  2. *A warm bath (n = 36, 30.3%)*
  3. *Exercise*
  4. Unsure

Questions 16–20 Knowledge of antipyretics and their use in fever management

16. Antipyretics reduce fever by:
  1. *Inhibiting prostaglandin activity (n = 83, 69.7%)*
  2. Reducing shivering
  3. Eliminating viral activity
  4. Decreasing bacterial response
  5. Unsure

17. The usual dose of paracetemol ordered for children 4 hourly is:
  1. 5mg/kg/dose
  2. 10mg/kg/dose
  3. *15mg/kg/dose (n = 101, 84.9%)*
  4. 20mg/kg/dose
  5. Unsure

18. The peak absorption time for paracetemol is:
  1. *10–60 minutes (n = 33, 27.7%)*
  2. 30–60 minutes
  3. 60–90 minutes
  4. 60–180 minutes
  5. Unsure

19. Which of the following is TRUE regarding fever management in children over 3 months of age:
  1. All children with increased temperatures require antipyretic therapy
  2. Fever of 38°C necessitates antibiotic therapy
  3. *Paracetemol is the most commonly used antipyretic (n = 104, 87.4%)*
  4. Fever in young children should be allowed to run its course
  5. Unsure

20. Side effects of paracetemol are: (Please circle all appropriate responses)
  1. *Liver toxicity*
  2. *Renal toxicity (n = 24, 20.2%)*
  3. Gastrointestinal irritability
  4. Unsure

Appendix F: An example of 'initial coding'

<u>A part of interview with interviewee A</u>

Researcher: What makes you want to take the interview part of this study?

A: It was the fever side that I was interested in. I was actually interested in whether there was any difference from what I would do and whether I would be on the right tracks if someone has a fever. More than anything, I was wondering if there is something different that they would do now. I am a great believer in tepid sponging but they say that we don't tepid sponge any more *(uncertain about fever knowledge after the questionnaire)*. Especially in children, I always found that that brought down the temperature really quickly and it was good, but from what I've read on the computer, they don't advocate that any more. It's really done by ibuprofen and paracetamol more than anything else over here.

Researcher: You could say that. I think that, nowadays, people are not very sure about how to deal with fever so that is why I designed this study. As a nurse myself, I used to work in ICU, I didn't know the exact way. I'm not 100% sure.

A: That's the way that I felt as well. I wasn't 100% sure that my care was the same as everybody else's. You need to send me your findings so that I know that I'm doing the right things.

<u>Another part of interview with interviewee A</u>

Researcher: When would you start to intervene the fever symptom or why?

A: Just so that the temperature doesn't go too high and they end up with a fever. I know that it's the body's response *(understanding fever mechanism)* but, at the same token, if it gets too high, they end up with certain things like convulsions or things like that *(worried about side effects of fever)*. I tend to try to keep the temperatures down because of that. It can cause kidney damage and things like that, so we’re trying to avoid major organ shutdowns.

Researcher: Yes, definitely. What do you think influenced your decision making when you were trying to make some interventions? How did you decide when to take their clothes off, when to give ibuprofen and things like that?

A: When the temperature goes up to over 37°, I tend to think, “Right, now is the time”, although I have gone to see kids with temperatures higher than that. I’ve seen kids at 40° and managed to get their temperature down before it caused any convulsions for that. Apart from anything else, it’s a frightening thing for the mums and dads to see them having febrile convulsions (*worried about side effects of fever, pressure from the family*). I just don’t want it to get to that point. I try my best to do as much as possible that is preventative rather than curing, and that actually happens.

Researcher: I certainly feel that way, too, because I worked in paediatrics. Parents usually worry a lot.

A: Very much.

Researcher: Yes, definitely. Do you think that sometimes you don’t feel like working in that way, for example, giving ibuprofen, tepid sponging or taking their clothes off?

A: I have never really come across anything where I have thought, “No-”. I wouldn’t do anything until the temperature goes up. I just keep them cool (*confident about fever management, tend to subside fever symptoms*).

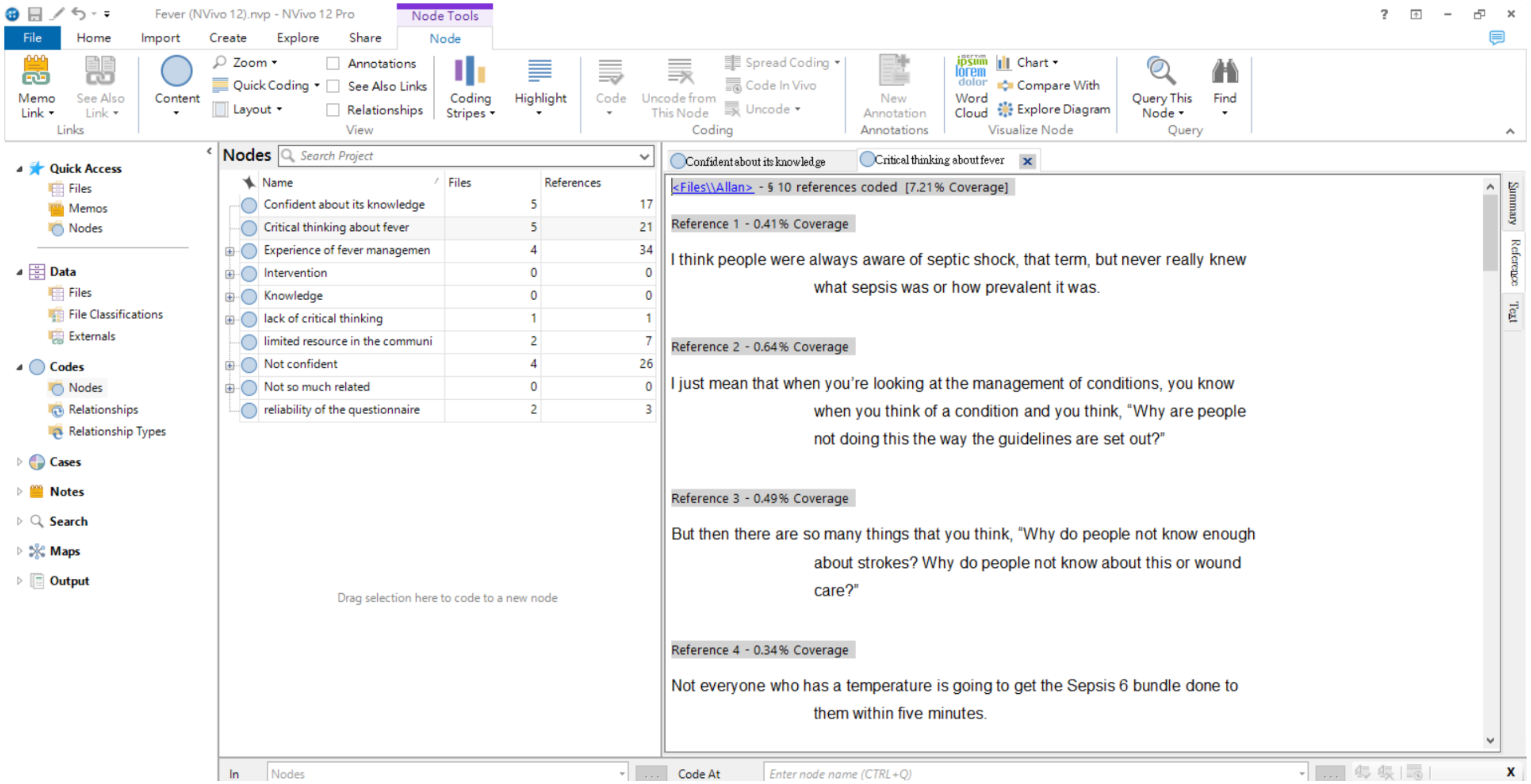
Appendix G: An example of the development of categories from initial codes to themes

Interview Quotation	**Initial Code**	**Focused Code**	**Theme**
I think people were always aware of septic shock, that term, but never really knew what sepsis was or how prevalent it was. I remember just before I qualified, and then just after qualifying, that whole Sepsis 6 bundle rolled out. There was a lot of focus on meeting all the six criteria in the bundle, which are, if I can remember them all. I should because I do bank research. (M)	Sepsis Six	Guideline-based management	Relating fever to infection
Sometimes, just on that, they would start an antibiotic. The samples, I'm not too sure how long they take, maybe 48 hours or longer than that. I'm not sure. I can't take blood cultures, but if they were very worried, they would take blood cultures and things as well. I think it depends on which doctor is on and if they have a persistent high temperature, they would say, "Do a full sepsis stream." (R)			

There is a neutropenic sepsis protocol…and that's because of the way it became sort of a cultural approach to managing fever. (C)	Neutropenic Sepsis guidance		
It's either sepsis, a similar sort of infection. You know, cold, flu or reaction to a drug or illicit substances. (G)	Suspecting infection as the cause of fever	Relating fever cause with their clinical experience	
Most of the temperatures that I get in and the febrile things are tonsillitis and the usual invasion by an infection of some kind. (A)			
So I think temperature is one of the key things that we look out for with our observations because of the risk of neutropenic sepsis or just sepsis in general. (C)	Worrying about fever developed into sepsis	Concerning about the development of fever cause	Fever phobia
The pyrexia is an indication that you've something way more serious going on here like sepsis or like a very adverse reaction to a drug.(G)			

Just so that the temperature doesn't go too high and they end up with a fever. I know that it's the body's response but, at the same token, if it gets too high, they end up with certain things like convulsions or things like that. I tend to try to keep the temperatures down because of that. (A)	Worrying about fever's side effect	Concerning about the side effect of fever	
I suppose if someone has a high temperature you are just quite concerned about them. You are wondering what's going on, because I think they're just at risk of deteriorating. (G)			
If it was persistently 37.8 °C or 37.9°C, then yes [would start to intervene fever]. Over 38°C, if they were also tachycardic and things like, would be a bit of a worry and also if they were sweating. (R)	Worrying about other complication with fever		

Appendix H: Nvivo



Appendix I: Analysis of demographic data and total knowledge score

The distribution of the total knowledge scores.

Total knowledge score	n	Percentage(%)
-11	2	1.1
-8	1	0.6
-7	4	2.3
-6	2	1.1
-5	9	5.1
-4	6	3.4
-3	13	7.3
-2	17	9.6
-1	10	5.7
0	22	12.4
1	13	7.3
2	11	6.2
3	16	9.0
4	13	7.3
5	11	6.2
6	10	5.7
7	4	2.3
8	7	4.0
9	3	1.7
10	2	1.1
11	1	0.6

Details of answers in fever knowledge questions. The underlined indicates the correct answer(s).

11. Raised temperature (pyrexia) is primarily attributed to:	**n**	**Percentage**
<u>Immune system</u>	77	43.50
Not sure	2	1.13
Pathogens	87	49.15
Weakening of the body due to illness	11	6.21

12. Fever is raising of the body temperature due to:	**n**	**Percentage**
Increase production of core temperature without temperature auto-regulation	80	45.20
Not sure	19	10.73
Reduced loss of core temperature	3	1.69
<u>Temperature auto-regulation of the body</u>	75	42.37

13. The increased temperature during fever is attributed to:	**n**	**Percentage**
Infection	77	43.50
<u>Infectious or non-infectious aetiology</u>	98	55.37
Not sure	1	0.56
Usually non-infectious aetiology	1	0.56

14. For every 1℃ rise in core temperature, heart rate increases by:	**n**	**Percentage**
<u>10 beats/ minute</u>	70	39.55
2 beats/ minute	17	9.60
5 beats/ minute	32	18.08
Not sure	58	32.77

15. For every 1℃ rise in temperature, there is an associated increase in respiratory rate of:	**n**	**Percentage**
<u>1-4 breaths per minute</u>	65	36.72
4-8 breaths per minute	40	22.60
Insignificant increase in breaths per minute	20	11.30
Not sure	52	29.38

16. The most accurate measurement of temperature is:	n	Percentage
Axillary	6	3.39
Not sure	8	4.52
Oral	4	2.26
Rectal	87	49.15
Tympanic membrane (Ear)	72	40.68

17. Fever control by active external cooling is justified in patients with:	n	Percentage
Acute kidney injury	9	5.08
Head injury	87	49.15
Malignancy	12	6.78
Not sure	69	38.98

18. What degree of temperature is NOT accepted as fever? (Please tick all appropriate responses)	n	Percentage
Rectal temperature 37.8°C (1)	42	23.7
Oral temperature 37.6°C (2)	54	30.5
Axillary temperature 37.4°C (3)	109	61.6
Tympanic membrane temperature 37.6°C (4)	59	33.3
Not sure	37	20.9

19. At what temperature would fever/hyperthermia cause brain damange? (Please tick all appropriate responses)	n	Percentage
39.5°C (1)	5	2.8
40.0°C (2)	30	16.9
40.5°C (3)	25	14.1
41.0°C (4)	50	28.2
41.5°C (5)	45	25.4
42.0°C (6)	84	47.5
Not sure	48	27.1

20. Antipyretics reduce fever because they:	n	Percentage
Cause vasodilation	34	19.2
Increase diaphoresis	11	6.2
Not sure	51	28.8
Suppress the action of prostaglandins	81	45.8

21. Side effects of paracetamol include: (Please tick all appropriate responses)	**n**	**Percentage**
Nausea/ vomiting (1)	53	29.94
Convulsions (2)	15	8.47
<u>Hepatic toxicity (3)</u>	166	93.79
Not sure	5	2.82

22. A side effect of the use of active cooling (e.g use of a cooling blanket) is:	**n**	**Percentage**
Hypothermia	27	15.25
Not sure	15	8.47
<u>Rigour (Chill)</u>	71	40.11
Sudden increase of reduction of temperature	64	36.16

23. The maximum dose of paracetamol in 24 hours should NOT exceed:	**n**	**Percentage**
<u>4 grams</u>	143	80.79
6 grams	12	6.78
8 grams	22	12.43

24. Paracetamol may cause: (Please tick all appropriate responses)	**n**	**Percentage**
<u>Renal toxicity</u>	44	24.86
<u>Liver toxicity</u>	167	94.35
Gastrointestinal irritability	51	28.81
Not sure	3	1.69

25. Beneficial consequences of fever include:	**n**	**Percentage**
Decreased body metabolic needs	9	5.08
Fat catabolism	10	5.65
<u>Increased antibody production</u>	112	63.28
Increased heart rate	4	2.26
Not sure	42	23.73

26. Which is NOT a beneficial effect of fever	n	Percentage
Acceleration of white blood cell production	19	10.73
An increase in serum iron production	41	23.16
Not sure	85	48.02
Promotion of antibiotic activity	19	10.73
Stimulation of T-lymphocyte production	13	7.34

27. The primary danger of fever (excluding the underlying cause) is:	n	Percentage
Brain damage	47	26.55
Dehydration	42	23.73
Febrile convulsions	80	45.20
None	1	0.56
Not sure	7	3.95

Correlation between the total knowledge score and education level. (Asymp. Sig. means asymptotic significance)

Education	**n**	**Mean Rank**	**Mann-Whitney U**	**Asymp. Sig. (2-tailed)**
Without State Registration Programme	140	91.08	2298.50	0.29
State Registration Programme	37	81.12		
Without Registered General Nurse Diploma	144	89.92	2243.50	0.62
Registered General Nurse Diploma	33	84.98		
Without Nursing Degree-BSc/BN	106	94.91	3136.50	0.06
Nursing Degree-BSc/BN	71	80.18		
Without Nursing Degree-BSc Hon/BN Hon	147	86.97	1906.00	0.24
Nursing Degree-BSc Hon/BN Hon	30	98.97		
Without Post Graduate/ Qualification-Diploma	137	88.23	2634.00	0.71
Post Graduate/ Qualification-Diploma	40	91.65		
Without Post Graduate/ Qualification-Masters	149	86.70	1744.00	0.17
Post Graduate/ Qualification-Masters	28	101.21		
Without Post Graduate/ Qualification-PhD/Professional Doctorate	176	88.94	78.00	0.84
Post Graduate/ Qualification-PhD/Professional Doctorate	1	99.00		

Correlation between the total knowledge score and different NHS boards. (Asymp. Sig. means asymptotic significance)

NHS Boards	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants not worked in Greater Glasgow & Clyde	118	91.88	3141.00	0.29
Participants worked in Greater Glasgow & Clyde	59	83.24		
Participants not worked in Lothian	113	84.97	3160.50	0.16
Participants worked in Lothian	64	96.12		
Participants not worked in Highland	164	88.26	944.00	0.49
Participants worked in Highland	13	98.38		
Participants not worked in Lanarkshire	166	90.08	734.00	0.28
Participants worked in Lanarkshire	11	72.73		
Participants not worked in Shetland	176	88.51	2.00	0.03
Participants worked in Shetland	1	175.00		
Participants not worked in Dumfries & Galloway	165	89.63	886.50	0.54
Participants worked in Dumfries & Galloway	12	80.38		
Participants not worked in Fife	162	90.23	1015.50	0.29
Participants worked in Fife	15	75.70		
Participants not worked in Tayside	176	88.50	0.00	0.01
Participants worked in Tayside	1	177.00		
Participants not worked in Borders	176	88.60	17.50	0.20
Participants worked in Borders	1	159.50		

Correlation between the total knowledge score and different clinical settings. (Asymp. Sig. means asymptotic significance, * indicates significant probability.)

Setting	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants working in other (non-hospital) setting	66	76.30	*2824.50	*0.01
Participants working in a hospital setting	111	96.55		
Participants working in other (non-medical centre) setting	166	89.58	817.50	0.56
Participants working in a medical centre setting	11	80.32		
Participants working in other (non-community) setting	138	95.11	*1847.50	*0.00
Participants working in a community setting	39	67.37		
Participants working in other (non-clinic) setting	172	88.66	371.00	0.60
Participants working in a clinic setting	5	100.80		
Participants working in other (non-school) setting	176	88.86	63.00	0.72
Participants working in a school setting	1	114.00		
Participants working in other (non- higher educational institute) setting	175	88.57	99.50	0.33
Participants working in a higher educational institute	2	126.75		
Participants working in other (non-research facility) setting	171	88.98	510.00	0.98
Participants working in a research facility	6	89.50		
Participants not working in the option of 'other' setting	175	89.35	113.00	0.42
Participants working in the option of 'other' setting	2	58.00		

The correlation between participants' current working units and their total knowledge score. (Asymp. Sig. mean asymptotic significance, * indicates significant probability. Participants not working in a hospital setting indicates that participants were working in a non-hospital setting. Therefore, it would be difficult for them to choose a unit.)

Current employment	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants working in other (non-critical care) unit	164	87.44	810.00	0.15
Participants working in critical care	13	108.69		
Participants working in other (non-acute care) unit	130	84.17	*2426.50	*0.04
Participants working in acute care	47	102.37		
Participants working in other (non-surgical) unit	160	88.77	1323.00	0.85
Participants working in surgical unit	17	91.18		
Participants working in other (non-medical) unit	162	87.82	1024.50	0.31
Participants working in medical unit	15	101.70		
Participants working in other (non-neuroscience) unit	172	87.05	*94.00	*0.00
Participants working in neuroscience	5	156.20		
Participants working in other (non-paediatric) unit	167	88.46	745.00	0.57
Participants working in paediatric unit	10	98.00		
Participants working in other (non-rehabilitation) unit	171	90.43	*268.50	*0.05
Participants working in rehabilitation	6	48.25		
Participants working in other (non-Psychiatric) unit	175	89.31	120.50	0.48
Participants working in Psychiatric unit	2	61.75	123.50	

Current employment	n	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants not working in the option of 'other' unit	128	84.23	*2525.00	*0.04
Participants working in the option of 'other' unit	49	101.47		
Participants who did not choose 'not in a hospital setting'	121	95.78	*2568.00	*0.01
Participants not working in a hospital setting	56	74.36		
Participants working in other (non-research facility) unit	156	86.45	1240.50	0.07
Participants working in research facility	21	107.93		

The correlation between nurses' past work experience at different units and their total knowledge score. (Asymp. Sig. means asymptotic significance, * indicates significant probability. Participants not working in a hospital setting indicates that participants were working in a non-hospital setting. Therefore, it would be difficult for them to choose a unit.)

Past employment	N	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants worked in other (non-critical care) unit	124	79.72	*2135.50	*0.00
Participants worked in critical care	53	110.71		
Participants worked in other (non-acute care) unit	77	72.56	*2584.50	*0.00
Participants worked in acute care	100	101.66		
Participants worked in other (non-surgical) unit	104	87.16	3604.50	0.57
Participants worked in surgical unit	73	91.62		
Participants worked in other (non-medical) unit	99	83.84	3350.00	0.13
Participants worked in medical unit	78	95.55		
Participants worked in other (non-neuroscience) unit	157	86.46	1172.00	0.06
Participants worked in neuroscience	20	108.90		
Participants worked in other (non-paediatric) unit	150	88.33	1924.00	0.68
Participants worked in paediatric unit	27	92.74		
Participants worked in other (non-rehabilitation) unit	148	92.51	*1626.00	*0.04
Participants worked in rehabilitation	29	71.07		
Participants worked in other (non-Psychiatric) unit	171	88.73	467.50	0.71
Participants worked in Psychiatric unit	6	96.58		
Participants not worked in the option of 'other' unit	111	81.66	*2848.50	*0.01
Participants worked in the option of 'other' unit	66	101.34		
Participants who did not choose 'not in a hospital setting'	106	98.81	*2723.50	*0.00
Participants not worked in a hospital setting	71	74.36		

Past employment	N	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants worked in other (non-theatre) unit	164	89.20	1033.50	0.85
Participants worked in theatre	13	86.50		
Participants worked in other (non-research facility) unit	156	86.45	1240.50	0.07
Participants worked in research facility	21	107.93		

The correlation between participants' nursing role and their total knowledge score. (NP means nurse practitioner, NS mean nurse specialist, Asymp. Sig. means asymptotic significance, * means significant probability)

Role	N	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
Participants working as a registered nurse and as another role	110	97.10	*2794.50	*0.01
Participants working only as a registered nurse	67	75.71		
Participants not working as charge nurse	153	88.37	1739.00	0.68
Participants working as charge nurse	24	93.04		
Participants not working as manager	170	87.96	418.00	0.18
Participants working as manager	7	114.29		
Participants not working as research	147	87.33	1960.00	0.34
Participants working as research	30	97.17		
Participants not working as np	161	85.34	*698.00	*0.00
Participants working as np	16	125.88		
Participants not working as ns	154	89.18	1743.50	0.90
Participants working as ns	23	87.80		
Participants not working as any other role above	165	89.55	899.00	0.59
Participants working as 'other' nursing role that was not listed above	12	81.42		

Appendix J: Correlation between knowledge questions

(Asymp. Sig. means asymptotic significance, * indicates significant probability)

Questions related to reasons of fever

Questions number	Asymp. Sig. (2-sided)	Phi
Q11, Q12	0.909	0.009
Q11, Q13	*0.025	0.169
Q12, Q13	0.885	0.011

Questions related to vital signs

Questions number	Asymp. Sig. (2-sided)	Phi
Q14, Q15	0.294	0.079

Questions related to temperature of fever

Questions number	Asymp. Sig. (2-sided)	Phi
Q16, Q18	*0.008	0.200
Q16, Q19	0.409	0.062
Q18, Q19	0.699	0.029

Questions related to mechanism of antipyretics

Questions number	Asymp. Sig. (2-sided)	Phi
Q17, Q20	0.118	0.118
Q17, Q22	0.070	-0.136
Q20, Q22		

Questions related to pharmacological antipyretics

Questions number	Asymp. Sig. (2-sided)	Phi
Q20, Q21	0.255	0.086
Q20, Q23	0.830	0.016
Q20, Q24	*0.010	0.192
Q21, Q23	0.384	-0.065
Q21, Q24	*0.000	0.323
Q23, 24Q	0.589	-0.041

Questions related to side effects of antipyretics

Questions number	Asymp. Sig. (2-sided)	Phi
Q21, Q22	0.931	0.007
Q21, Q24	*0.000	0.323
Q22, Q24	0.914	-0.008

Questions related to benefits and side effects of fever

Questions number	Asymp. Sig. (2-sided)	Phi
Q25, Q26	*0.003	0.224
Q25, Q27	0.877	0.012
Q26, Q27	0.594	0.040

Appendix K: Correlation between questions related to fever knowledge and fever management

(Asymp. Sig. means asymptotic significance, * indicates significant probability)

Cross tabulations of questions related to mechanism of antipyretics and two most popular methods of fever management among the participants' first three choices.

Questions, Choice of fever management	Asymp. Sig. (2-sided)	Phi
Q20, 1st choice- paracetamol PO	0.264	-0.084
Q20, 1st choice- fan	0.160	0.106
Q20, 2nd choice- ibuprofen	0.585	-0.041
Q20, 2nd choice- fan	0.089	-0.128
Q20, 3rd choice- fan	0.473	-0.054
Q20, 3rd choice- tepid sponging	0.866	0.013
Q21, 1st choice- paracetamol	0.947	-0.005
Q21, 1st choice- fan	0.423	-0.060
Q21, 2nd choice- ibuprofen	0.816	-0.017
Q21, 2nd choice- fan	0.330	-0.073
Q21, 3rd choice- fan	0.658	0.033
Q21, 3rd choice- tepid sponging	0.450	-0.057
Q22, 1st choice- paracetamol PO	0.326	0.074
Q22, 1st choice- fan	0.826	-0.017
Q22, 2nd choice- ibuprofen	0.540	0.046
Q22, 2nd choice- fan	0.599	-0.040
Q22, 3rd choice- fan	*0.007	0.203
Q22, 3rd choice- tepid sponging	0.191	0.098
Q24, 1st choice- paracetamol PO	0.484	0.053
Q24, 1st choice- fan	0.489	-0.052
Q24, 2nd choice- ibuprofen	0.825	0.017
Q24, 2nd choice- fan	0.378	-0.066
Q24, 3rd choice- fan	*0.013	0.187
Q24, 3rd choice- tepid sponging	0.893	0.010

Cross tabulations of questions related to non-pharmacological antipyretics and selection of non-pharmacological antipyretics among the participants' first three choices

Questions, Choice of fever management	Asymp. Sig. (2-sided)	Phi
Q17, 1st choice- ice packs	0.973	0.003
Q17, 1st choice- water blanket		
Q17, 1st choice- air blanket	0.148	0.109
Q17, 1st choice- water pads	0.148	0.109
Q17, 1st choice- fan	0.247	-0.087
Q17, 1st choice- cool air	*0.001	0.243
Q17, 1st choice- tepid sponging	0.219	-0.092
Q17, 2nd choice- ice packs	0.800	-0.019
Q17, 2nd choice- water blanket	0.541	0.046
Q17, 2nd choice- air blanket	0.383	0.066
Q17, 2nd choice- water pads	0.580	-0.042
Q17, 2nd choice- fan	0.763	0.023
Q17, 2nd choice- cool air	0.753	0.024
Q17, 2nd choice- tepid sponging	0.171	0.103
Q17, 3rd choice- ice packs	0.423	-0.060
Q17, 3rd choice- water blanket	0.580	-0.042
Q17, 3rd choice- air blanket	0.800	-0.019
Q17, 3rd choice- water pads	0.666	0.032
Q17, 3rd choice- fan	0.502	0.050
Q17, 3rd choice- cool air	0.402	0.063
Q17, 3rd choice- tepid sponging	0.623	0.037
Q22, 1st choice- ice packs	0.098	-0.124
Q22, 1st choice- water blanket		

Q22, 1st choice- air blanket	0.244	-0.087
Q22, 1st choice- water pads	0.774	0.022
Q22, 1st choice- fan	0.826	-0.017
Q22, 1st choice- cool air	0.422	-0.060
Q22, 1st choice- tepid sponging	0.131	0.114
Q22, 2nd choice- ice packs	0.793	-0.020
Q22, 2nd choice- water blanket	0.809	-0.018
Q22, 2nd choice- air blanket	0.615	0.038
Q22, 2nd choice- water pads	0.153	-0.107
Q22, 2nd choice- fan	0.599	-0.040
Q22, 2nd choice- cool air	0.090	0.127
Q22, 2nd choice- tepid sponging	*0.019	-0.177
Q22, 3rd choice- ice packs	0.294	0.079
Q22, 3rd choice- water blanket	0.344	0.071
Q22, 3rd choice- air blanket	0.793	-0.020
Q22, 3rd choice- water pads	0.155	-0.107
Q22, 3rd choice- fan	*0.007	0.203
Q22, 3rd choice- cool air	0.925	0.007
Q22, 3rd choice- tepid sponging	0.191	0.098

Cross tabulations of questions related to pharmacological antipyretics and selection of pharmacological antipyretics among the participants' first three choices

Questions, Choice of fever management	**Asymp. Sig. (2-sided)**	**Phi**
Q20, 1st choice- paracetamol PO	0.264	-0.084
Q20, 1st choice- paracetamol IV	*0.010	0.194
Q20, 1st choice- ibuprofen	0.518	-0.049

Q20, 1st choice- aspirin	0.057	0.143
Q21, 2nd choice- paracetamol PO	0.892	0.010
Q21, 2nd choice- paracetamol IV	0.492	0.052
Q21, 2nd choice- ibuprofen	0.816	-0.017
Q21, 2nd choice- aspirin	0.537	0.046
Q23, 3rd choice- paracetamol PO	0.133	0.113
Q23, 3rd choice- paracetamol IV	0.732	-0.026
Q23, 3rd choice- ibuprofen	0.168	0.104
Q23, 3rd choice- aspirin	0.231	-0.090
Q24, 4th choice- paracetamol PO		
Q24, 4th choice- paracetamol IV		
Q24, 4th choice- ibuprofen		
Q24, 4th choice- aspirin		

Appendix L: List of attended conferences and publications

Conferences

05/2018	**2018 SHSS PGR Conference**
	-Poster presentation
04/2018	**Taiwan Scientific Symposium Edinburgh**
	-Oral presentation
03/2018	**Lothian NMAHPPS Research Conference,**
	-Oral presentation
08/2017	**The 2nd Asia-Pacific Nursing Research Conference**
	-Oral presentation
04/2016	**2016 SHSS PGR Conference**
	-Oral presentation

Publications

Lu-Yen. Chen, Ming-Lin. Wang, Yu-Fen. Su, Shiow-Ching. Sun (2015). Nursing care of a Nephrotic Syndrome with Deep Vein Thrombosis Patient. National Taiwan University Hospital Journal of Nursing, *10*(2), p145-157

Lu-Yen A., Chen & Tonks N., Fawcett (2016). Using Data Mining Strategies in Clinical Decision Making: A Literature Review. *CIN: Computers, Informatics, Nursing*,*34*(10), p448-454. doi:10.1097/CIN.0000000000000282

Chen, L. Y. A., & Fawcett, T. N. (2017). Service evaluation: A grey area of research?. Nursing ethics, 0969733017742961. doi:10.1177/0969733017742961